FAMOUS GEOLOGIST IS DEAD.

Prof. Jules Marcou, Friend of Agassiz, Passes Away at Cambridge.

NEW YORK, April 19.—Professor Jules Marcou, the noted geologist, died to-day at his home in Cambridge, Mass. He was the friend of Agassiz and accompanied that great scientist on his memorable journey to the United States and Canada in 1848. The purpose of this celebrated mission was to gather geological specimens for the Jardin des Plantes of Paris

So much was Marcou impressed with facilities for geological investigation in America that he returned hither and entered the employ of the United States government. After a rest in Europe (which was improved by holding a professorship at Zurich), he came back to America with the illustrious Agassiz and founded the Museum of Comparative Zoology, in which he was master of the paleontological department.

Professor Marcou's scientific works are many and valuable. He was 74 years old.

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THE AMERICAN NATURALIST

VOL. XXXII. *March, 1898.* NO. 375.

LOUIS AGASSIZ.

Two extensive accounts of the life of Louis Agassiz have already been written, one from the hands of Mrs. Agassiz, the revered president of Radcliffe College, the other by his life-long friend Jules Marcou. We have no intention of preparing a third, nor do we expect to throw new light upon the subject. We only offer an outline of his life merely as an introduction to the following articles, which deal with some of the special studies of the great naturalist.

Louis Jean Rudolf Agassiz, descendant from a long line of ministers, was born at the little village of Motier, Switzerland, between the lakes of Neuchâtel and Morat, May 28, 1807. In his early years he showed great fondness for the water and for the animals to be found in it, as well as for athletic sports; and when the time came for him to make the decision as to his life work, he turned aside from the ministry and from a business career and went to Zürich to study medicine. The school at Zürich at that time was nothing like that of to-day, for then the present university was not founded. So from Zürich he turned to Heidelberg, where he made acquaintances and friends,—the Schimpers and Brauns, who were to play no small part in his future development, some of these friendships persisting throughout his life. Here at Heidelberg he obtained

his first introduction into zoology and paleontology, fields which he was later to make peculiarly his own. For still greater facilities he and his friends soon turned to the newly established University of Munich, where in 1830 he received the degree of Doctor of Medicine.

During these undergraduate days he paid more attention to zoology than to the strictly medical studies, and his room became a great resort for others having similar tastes. Here each member had his special subject and delivered lectures upon it to the others, so that the term, "the little academy," applied to these meetings contained as much truth as jest. The life which Agassiz lived here has a lesson for our students. Making due allowance for the differences in prices, the money which his father and friends could give him for his education would fall far below that spent by our students to-day, and yet out of this pittance Agassiz not only supported himself and aided friends, but he employed an artist to draw the fishes for proposed works,—the fishes of central Europe and those collected by Martius and Spix in Brazil.

Here, too, he began his investigations upon the fossil fishes, and soon, by borrowing, he had at his command an enormous collection of these forms. The task was enough to appall most persons. The fossils were in all conditions of preservation, and in those days little was known of the osteology of the recent forms. Yet order was brought out of chaos, and these early studies were the foundation of all subsequent work in this line. It matters little if we can no longer use the scales as a character for the separation of the major groups of the fish-like forms; the *Researches on Fossil Fishes* shows great anatomical insight and powers of generalization.

These studies of fishes led him to Paris, then the great centre of all scientific work, and here he formed the acquaintance of Cuvier and Humboldt, and Cuvier opened the collections of fossil fishes in the museum to the young student. While in Paris he received the appointment as Professor of Natural Science at the Academy of Neuchâtel. When he began his labors there he was without facilities for his work; collections and apparatus, aside from his own private property, were lack-

ing; even rooms for his classes were with difficulty obtained. Yet he soon built up a most flourishing school of natural history. Out of his limited salary he supported collectors, assistants, artists, and secretaries. He went farther and became his own publisher and started a large lithographic establishment, the chief business of which was to furnish illustrations, in a style until then never seen, for the rapidly increasing series of works turned out from the busy hive.

The school at Neuchâtel was not a university, but Agassiz made it one of the scientific centres of the world. To it came visitors and students from all parts of Europe. That its prominence at this time was due solely to Agassiz is shown by the fact that when he left for the United States the academy at once sank back to its former inconspicuous condition, just as Upsala did when Linné died.

While here at Neuchâtel, pushing along the work on the fishes of central Europe, the fossil fishes, and the fossil echinoderms of the Jura, he became interested in the glaciers. To others we owe the discovery that glaciers move, and that in former times they covered more of Switzerland than they do to-day. At first Agassiz had little sympathy with such ideas, but as he studied the phenomena in the valley of the Rhone he was converted to the new views, and soon became the foremost authority in all that pertains to glaciers. Even were we to allow to Forbes and Schimper all that they claim, still it would be to Agassiz that we owe the systematization of the facts and the acceptance of the principles involved by the scientific world. As the work left Agassiz's hands it was about as complete as it could be without a knowledge of physical methods and phenomena such as Agassiz never claimed to have. Later Tyndall built upon Agassiz's foundation the glacial theory of to-day, rounding it out on the physical side and making it complete.

Each summer during these glacial studies was spent upon some of the glaciers of the Alps, where regular investigations of the most elaborate kind were carried on with the best of instruments, the Glacier of the Aar being the one the most thoroughly investigated. During the rest of the year Agassiz

worked at Neuchâtel, teaching his classes, directing his assistants, artists, etc., and working away at his various books, of which he had now in hand, besides those already mentioned, one upon fossil molluscs and one — the *Nomenclator Zoologicus* — the compilation of which must have been about as tedious a bit of work as one could easily imagine, but a work indispensable to the systematic zoologist of to-day. His work on fossil fishes had extended his reputation, and the treasures in the collections of several wealthy patrons of science in England were poured in to be worked over and incorporated in the series of volumes on these forms.

So from the scientific standpoint, affairs were most prosperous during these years at Neuchâtel, but financially they were far less rosy. Agassiz was not a business man, and his publications and his lithographic establishment were a terrible load. Books upon subjects of pure science never have paid their expenses, and the prospect is that they never will. So all the bills for artists, assistants, lithographers, and printers had to be paid from the small income of a professor in a provincial academy. At last the limit was reached and the lithographic establishment had to be sold.

At this time of financial distress Agassiz received, through the good services of Lyell, the geologist, an invitation to deliver a course of lectures before that unique institution, the Lowell Institute in Boston. Here was a chance to see the New World, and the opportunity was the more eagerly seized since the king of Prussia (Neuchâtel was then a part of the Prussian domain) gave Agassiz $3000. to aid him in his American explorations. Leave of absence was obtained from the academy at Neuchâtel and in 1846 Agassiz left for America, never to return to his Swiss home except as a visitor for a few months.

Boston received the newcomer with the greatest cordiality, and a little later Philadelphia and Charleston were scarcely behind in the warmth of their welcome. He hired a house in East Boston, and this soon became almost a repetition of the old home at Neuchâtel. Together with Agassiz, or following close upon his heels, came one after another of the old Swiss

friends and assistants, — Desor, Guyot, Marcou, Pourtalés, Girard, Richard, Sonrel, Burckhardt, and others, — so that it may be said that the work was merely transferred from the Old World to the New, the personnel of the establishment being much the same, but the work was changed in character.

In 1847 came the appointment to the Chair of Zoology and Geology in the newly established Lawrence Scientific School of Harvard College, and in the winter of 1848 Agassiz began his work as an instructor in the New World, — work which continued until his death, even the invitation to return to Paris as the head of the museum there being insufficient to call him back to Europe.

With this change from the Old World to the New, the work of Agassiz changed. It was not only that there was a change in the fauna: there was also a change in the man. In Europe his work had been largely systematic, although all of his papers had a strong substructure of anatomy. In America, surrounded as he was by a wealth of new and undescribed forms, one might have expected him to have become more purely a systematist than ever before. He became rather what to-day we would call a morphologist, and it is noticeable that in the majority of the papers he published in America, the structural or developmental side of the subject is the more prominent, the descriptions of new species occupying a subsidiary position.

Domiciled at Cambridge, Agassiz began collecting as never before. From all parts of the country specimens were obtained, but the only place for storage of them was a barn-like structure near the banks of the Charles. His trips to Charleston, where he early received an appointment in the medical school, enabled him to make collections in the semitropical waters there, while a trip to Lake Superior in 1848 resulted in large fresh-water collections. Besides, he arranged for exchanges of specimens with the museums of Europe and this country, and soon a larger building, a two-storied structure, long known as Zoological Hall, became the home of the specimens. This, however, was not safe from fire. It was built of wood, and, besides, a great part of the collections were preserved in alcohol, even more inflammable than the building itself. But where the

money to build according to his desires was to be obtained was for a long time a serious problem.

In 1858 Mr. Francis C. Gray left in the hands of trustees a bequest of $50,000 to establish a museum of comparative zoology. This fund was passed over into the control of Harvard College; friends raised by subscription over $70,000, while Agassiz labored with the Massachusetts legislature to such good effect that the Commonwealth appropriated $100,000 to properly house the collections. To the Museum of Comparative Zoology thus established — the Agassiz Museum as it is familiarly known in Cambridge to this time — Agassiz gave his private collections which had cost him in pecuniary outlay about $10,000.

The building then planned was to form three sides of a hollow square, the front to be 364 feet long and 64 feet wide, the two wings to be 205 feet long and as wide as the front. The part at first erected was but about two-fifths of one of the wings, and this portion, sufficient for all immediate needs, was formerly opened as a museum in November, 1860. To-day the whole of one wing is completed, about four-fifths of the front is occupied, while two-fifths of the other wing is built. There has been, however, a change in the plans in this respect. The museum is not purely zoological in character, but it contains as well the laboratories and collections of geology, mineralogy, and a large part of the botanical laboratories and collections (except the phanerogamic herbarium, kept at the Botanic Garden); while the Peabody Museum of American Archæology and Ethnology occupies the incomplete wing. Corresponding to this change, the whole structure is now known as the University Museums, the Museum of Comparative Zoology occupying the basement and five floors of one of the wings and a part of the front, with a total floor area of nearly three acres.

During his American life Agassiz made several extended scientific trips. In 1851 he went to Florida under the auspices of the United States Coast Survey; in 1865–66 he spent, with a party of friends, assistants, and pupils, ten months in Brazil, collecting chiefly in the valleys of the Amazon and Rio Negro, bringing back with him enormous collections to add to those

already at Cambridge. In 1871, again enjoying the hospitality of the Coast Survey, he sailed from Boston in the steamer "Hasler," passed through the Strait of Magellan, up along the west coast of South America and the Galapagos Archipelago, and finally reached San Francisco. This last trip was in many ways a disappointment, for the steamer itself was in poor condition and its equipment inadequate for deep sea dredging. Yet the collections made were very considerable.

But we must return to Agassiz's work at Cambridge, and especially to his work as a teacher. As time passed most of those who came with him from Europe either returned or obtained occupation elsewhere; but their places were taken by American students who were attracted to Cambridge by his name. It may be said that no teacher in recent years, unless it be the venerable Leuckart at Leipzig, has trained so many students who later arose to prominence in scientific lines as did Agassiz. The following names occur to us at the moment of writing — a little research would doubtless add to the number: J. G. Anthony, Alexander Agassiz, J. A. Allen, J. M. Barnard, Albert Bickmore, W. K. Brooks, Waldo I. Burnett, Caleb Cooke, Henry James Clarke, Thomas Clarke, William H. Dall, Walter Faxon, Jesse W. Fewkes, Samuel Garman, Charles Hamlin, Frederick C. Hartt, Alpheus Hyatt, William James, David S. Jordan, John L. Le Conte, Theodore Lyman, Horace Mann, James E. Mills, Charles S. Minot, Edward S. Morse, John Macready, William H. Niles, Albert S. Ordway, Alpheus S. Packard, John B. Perry, Frederick W. Putnam, Nathaniel S. Shaler, Samuel H. Scudder, William Stimpson, Sanborn Tenney, Philip R. Uhler, Addison E. Verrill, Burt G. Wilder, and Charles O. Whitman. When we look over the names of those who are doing the zoological work of America to-day, we find few who have not been trained by Agassiz, by his pupils, or by his pupils' pupils.

Agassiz's method of teaching was largely the laboratory method which we know to-day. Mr. Scudder has so well described his experience when he first went to study entomology with Agassiz that we cannot refrain from quoting from his account :

"When do you wish to begin?" he asked.

"Now," I replied.

This seemed to please him, and, with an energetic "very well," he reached from a shelf a huge jar of specimens in yellow alcohol.

"Take this fish," said he, "and look at it; we call it a Hæmulon. By and by I will ask you what you have seen."

With that he left me, but in a moment returned with explicit instructions as to the care of the object intrusted to me. "No man is fit to be a naturalist," said he, "who does not know how to take care of specimens." . . . Entomology was a cleaner science than ichthyology, but the example of the professor, who had unhesitatingly plunged to the bottom of the jar to produce the fish, was infectious; and though this alcohol had a very ancient and fish-like smell, I really dared not show any aversion within these sacred precincts, and treated the alcohol as though it were pure water. . . . In ten minutes I had seen all that could be seen in that fish. . . . Half an hour passed, an hour, another hour; the fish began to look loathsome. I turned it over and around; looked it in the face — ghastly! From behind, beneath, above, sideways, at a three-quarters view — just as ghastly! I was in despair. At an early hour I concluded that lunch was necessary; so, with infinite relief, the fish was carefully replaced in the jar, and for an hour I was free. . . .

Slowly I drew forth that hideous fish, and, with a feeling of desperation, again looked at it. I might not use a magnifying glass; instruments of all kinds were interdicted. My two hands, my two eyes, and the fish, — it seemed a most limited field. . . . At last a happy thought struck me, — I would draw the fish; and now, with surprise, I began to discover new features in the creature. Just then the professor returned.

"That is right," said he; "a pencil is one of the best eyes. I am glad to notice, too, that you keep your specimen wet and your bottle corked." With these encouraging words, he added: "Well, what is it like?"

He listened attentively to my brief rehearsal of the structure of parts whose names were still unknown to me. . . . When I had finished, he waited, as if expecting more, and then, with an air of disappointment, "You have not looked very carefully. Why," he continued most earnestly, "you have n't even seen one of the most conspicuous features of the animal, which is as plainly before your eyes as the fish itself. Look again! look again!" and he left me to my misery.

I was piqued; I was mortified. Still more of that wretched fish! But now I set myself to my task with a will, and discovered one new thing after another, until I saw how just the professor's criticism had been. The afternoon passed quickly, and when toward its close the professor inquired, "Do you see it yet?"

"No," I replied, "I am certain I do not; but I see how little I saw before."

"That is next best," said he earnestly; "but I won't hear you now. Put

away your fish and go home; perhaps you will be ready with a better answer in the morning. I will examine you before you look at the fish."

This was disconcerting. Not only must I think of my fish all night, studying, without the object before me, what this unknown but most visible feature might be, but also, without reviewing my new discoveries, I must give an exact account of them the next day. . . .

The cordial greeting from the professor the next morning was reassuring. Here was a man who seemed to be quite as anxious as I that I should see for myself what he saw.

"Do you, perhaps, mean," I asked, "that the fish has symmetrical sides with paired organs?"

His thoroughly pleased "Of course, of course!" repaid the wakeful hours of the previous night. After he had discoursed most happily and enthusiastically — as he always did — upon the importance of this point, I ventured to ask what I should do next.

"Oh, look at your fish!" he said, and left me again to my own devices. In a little more than an hour he returned, and heard my new catalogue.

"That is good, that is good," he repeated; "but that is not all; go on." And so for three long days he placed that fish before my eyes, forbidding me to look at anything else or to use any artificial aid. "Look! look! look!" was his repeated injunction.

This was the best entomological lesson I ever had, — a lesson whose influence has extended to the details of every subsequent study; a legacy that the professor has left to me, as he left it to many others, of inestimable value, which we could not buy, with which we cannot part.

Agassiz did a great work by his teaching, but he reached a wider circle by his popular lectures delivered before lyceums, teachers' associations, and farmers' institutes, as well as by his writings. Considering the time of its publication, no better text-book has ever appeared than the *Principles of Zoology* by Agassiz and Gould, first issued in 1848. Of this work, which bears the impress of Agassiz on every page, only the first part was ever published, but this part has passed through many editions and has a sale even to-day. The second part was prepared by Dr. Gould; the manuscript was written out, many of the engravings made, but Agassiz never found time to revise it as he wished. Other popular works which extended the influence of Agassiz far and wide were his *Methods of Study in Natural History*, first published in the *Atlantic Monthly*, and his two series of *Geological Sketches*, most of which first appeared in the same periodical.

In his more strictly scientific publications Agassiz employed the same sumptuous mechanical dress for his thoughts here as he did in Europe, and his *Contributions to the Natural History of the United States* is, even at this day, but rarely surpassed in beauty of presswork and quality of illustration. This work was to have been issued in ten quarto volumes, and the subscription list obtained (over 2500) before the first volume was issued is an index of the popular esteem in which the professor was held. Only four volumes were published and then the series stopped. Doubtless many of the subscribers expected gaily colored plates of birds and fishes and shells, such as were to be found in the then recently issued *Natural History of the State of New York*, and possibly some of them expected popular disquisitions on animals and plants something after the same style as was later furnished by the garrulous Rev. J. G. Wood. They received nothing of the sort. These four volumes were filled with an elaborate essay on the principles of zoological classification, a minute account of the development of the turtle, and details of the anatomy and histology of the Cœlenterata. The result was that the subscribers fell off. Agassiz, too, had so much other work to do that the series was never completed.

These same volumes, however, possessed great scientific value, and the *Essay on Classification* should be read by all, for nowhere will one find a clearer statement of the teleological argument, nowhere a better survey of the various systems of classification proposed at different times by the older masters. The work on the turtles is referred to elsewhere in this journal, but the studies upon the cœlenterates must not be ignored. This work marked a new departure in Agassiz's work. In Europe, removed as he was from the sea, he had no chance to study these forms, but at East Boston, at Charleston, and at his summer residence at Nahant this new world was opened up to him. So in the two volumes of the *Contributions* which deal with the cœlenterates we have a most valuable contribution to our knowledge of these forms. Here we find the demonstration that the millipores belong to the Hydrozoa rather than to the Scyphozoa. Here we find accounts of the life histories

of many of our hydroids; here details of the histology of these interesting forms. It is true that we can no longer agree with some of his theses. We no longer accept his views as to the homologies of the Radiata, nor can we longer adopt the Radiate group; but these changes, due to our increase of knowledge, detract but little from the general value of the work.

These volumes form the only extensive work published by Agassiz during his residence in America, but his shorter papers are both numerous and valuable.[1] He planned numerous other works, but none of these plans were carried out. The labor of teaching and the work demanded by a great and rapidly growing museum so completely occupied his time that there was no chance to carry out these contemplated investigations.

Three times was Agassiz recalled to Europe: in 1855 to the chair of zoology in the newly established University of Zurich, in 1857 to the head of the Jardin des Plantes in Paris, and in 1859 again to the same position. In spite of all of the attractions of these positions, he decided to remain in America, and at the beginning of our Civil War he showed his faith in the United States by becoming a naturalized citizen,—an American by right as well as by residence.

During the latter years of his life his originally strong constitution began to show the effects of early exposure and of overwork. Several times he had to give up entirely and to rest, but any long rest was impossible for him. In 1873 came the chance to establish a summer school for teachers, and the labors connected with the short-lived but ever-memorable school at Penikese told severely upon him. Still he kept at work, and even as late as the 2d of December he delivered a lecture before a farmers' institute at Fitchburg, his last public appearance. December 6 he was taken with paralysis of the larynx, and on Dec. 14, 1873, death came. Agassiz is buried at Mt. Auburn, and his monument is an Alpine boulder from the Glacier of the Aar, while around it grow pines transplanted from the hill behind Neuchâtel.

[1] A practically complete bibliography is given in Marcou's *Life of Agassiz*. It enumerates 425 titles.

THE PHILOSOPHICAL VIEWS OF AGASSIZ.

ALPHEUS S. PACKARD.

THE school of biological thinkers and writers to which Louis Agassiz belonged was that of Cuvier and of Owen. He was, however, the pupil of Döllinger, who revolutionized the methods of teaching in zoology, and he warmly sympathized with and adopted the views and principles of Von Baer, the great embryologist.

The half-century which has passed since Agassiz came to America has seen a profound and widespread modification of the methods of attacking biological problems. The facts may be of the same general nature, but their interpretation has radically changed; and it is fair to say that the labors of Agassiz in embryology and paleontology had some influence in leading to this change.

The impression made by Agassiz on the writer's mind, when a student for three years in the great museum he founded, was one of admiration at his broad, comprehensive, and synthetic views, his facility in wide generalization, his knowledge of the work done by his contemporaries and predecessors in comparative anatomy, embryology, and systematic zoology, and his acquaintance with the literature of these subjects. We realized that he was constantly in touch with the leading investigators in Europe. We were sure we were enjoying the privilege of working under the direction of a ripe zoological scholar and of the best equipped teacher of his age. It did not seem necessary to go to Germany, for we were enjoying advantages equal to those of the best German laboratories.

To-day we find more practical teachers than Agassiz, in that the student receives more of the teacher's time, is carried on from one step to another, is taught the use of the microtome and of reagents, and in most cases — for there are brilliant exceptions — half or two-thirds of the results as embodied in the doctor's thesis represent the work of the teacher who has

suggested the subject and laid out the plan of study, with a minor portion really contributed by the student himself.

Agassiz may have left his students too much to themselves, but he had what most teachers do not possess, — the power of leading his students to take broad views of a subject. As a teacher, then, Agassiz was broad and philosophical, and his pupils were constantly urged to add to their special work on the anatomy or embryology of some animal a wider knowledge of the relations of the animal itself to its allies and to the world it lived in, and more particularly to its fossil allies.

Philosophy inquires into the causes and meaning of things, philosophy thinks and speculates, and philosophy is nothing unless comparative in its methods. Agassiz was in season and out of season urging us to think at every stage of our investigation, to inquire what is the meaning of this or that feature or change in organs during growth, and at every step we were told to compare. His earliest lectures, delivered to popular audiences, soon after his arrival in this country were on "Comparative Embryology." The great museum he founded was the Museum of Comparative Zoology. Whatever he wrote or whenever he spoke his ideas were large, synthetic, and philosophical. It was these magnificent qualities, together with his undying enthusiasm, which made Agassiz one of the greatest of teachers in that line of great teachers of modern biology whose intellectual parents were Döllinger and Von Baer.

From Agassiz as a philosophical teacher let us turn to his work as an investigator, and inquire whether philosophic, synthetic methods were here employed by him.

Undoubtedly Agassiz's most important, far-reaching, and permanent contribution to science was the glacial theory. At the outset prejudiced against the idea of Venetz and of Charpentier as to the former great extent of the Swiss glaciers, after personal conversation and discussion with the latter geologist he became convinced of his error. He spent several summers among the Swiss glaciers, afterwards visited Great Britain, observed moraines, studied rocks and boulders, and inferred that glaciers had formerly existed in Wales and Scotland, that northern Europe had once been

mantled in ice, and that there had been a great ice age in that part of the earth. If he was a philosopher, he was not less a man of the world, a skillful and ready debater, a hard hitter in controversy, a persuasive and silver-tongued orator; and thus equipped, he overcame the prejudices of the geologists of that day, who were then wedded to diluvial currents, debacles, as well as impossible subsidences; and before his advent to these shores, he had convinced the scientific world that the greater part of the eastern hemisphere had been ice clad. Always observing and comparing, when he landed at Halifax and journeyed to Boston, afterwards geologizing in the White, Green, and Adirondack Mountains and about Lake Superior, he firmly established the truth of a general glacial period. And it is rather interesting to note that while the universality of the Darwinian theory of the formation of atolls by subsidence is now very generally called in question, and the adequacy of the theory of natural selection as a *vera causa*, or at least a primary factor, in evolution is denied by such a philosopher as Herbert Spencer, and by many evolutionists, the glacial theory is universally held, its opponents being so few that we can count them on the fingers of one hand.

When, however, we consider Agassiz as a zoologist or a biologist, and remember the determined way in which he opposed the doctrine of evolution in pre-Darwinian days, attacking on every occasion Lamarckism and the views of the *Vestiges of Creation*, and after the publication of the *Origin of Species*, letting no opportunity be lost in combating its supposed heretical views, we might be led to say, as has been said, that, after all, Agassiz was no philosopher; that he was slightly fanatical and somewhat bigoted and set in his views and illogical in his methods. It is true that in his prime and after a lifelong work in teaching the facts and principles which underlie and form the foundation on which the doctrine of evolution rests, he illogically stopped short of obvious and natural conclusions, and, unlike Lyell, Dana, and others, failed to adopt the new views.

The causes of his failure to come into line with the new zoology were in part, perhaps, the result of theological preju-

dice, of scientific conservatism, and other subtle reasons, and in part the result of his trained scientific mind accustomed to think more or less in one channel, not allowing itself to speculate too freely on too few facts. On the whole, however, the theory of descent was contrary to his whole nature and training; we can in this regard only liken the career of this great naturalist to one of his own "closed types." There are zoologists who attempt the impossible; who would refer, for example, the origin of vertebrates to Crustacea or to Limulus, overlooking the fact that these classes are the final terms in lines of development and are fully completed. So the special creation idea was unproductive, and a Darwin was needed to open men's eyes to new conceptions, to illumine well-known facts from a fresh point of view.

But it should never be forgotten that Agassiz from the beginning of his career advocated certain doctrines which underlie the theory of descent. The first of these is the foundation of the biogenetic law. He insisted that the development of the individual is an epitome of that of the order or class to which it belonged, though unfortunately he stopped short of the logical outcome of such a generalization; *i.e.*, that there is an organic or genetic connection between the forms composing the class.

The second principle is the parallelism between the geological succession of animals and their respective rank in the present period. He points out repeatedly that the lower types preceded the higher. For example, in the Crustacea the gradation of forms presents the most perfect coincidence with the order of succession of these animals in past geological ages. His "lowest" forms are the generalized types of zoologists of the present day, and his "higher" types the more specialized.

All this prepared the minds of his students to accept the truth of a process of evolution of life-forms from the generalized to the specialized types. His "embryonic," "synthetic," and "prophetic" types are in many cases the ancestral types of the modern evolutionist. His embryonic types "represent in their whole organization early stages of the growth of higher representatives of the same type." He maintained that "the

phases of development of all living animals correspond to the order of succession of their extinct representatives in past geological times. As far as this goes, the oldest representatives of every class may then be considered as embryonic types of their respective orders or families among the living."

Agassiz's prophetic types are those which "combine in their structure peculiarities which at later periods are only observed separately in different distinct types." As examples he mentions the ganoids, fishes, pterodactyles, and the ichthyosaurs. He, however, regarded ganoids as more distinctively synthetic than prophetic types. Now we refer the origin of bony fishes, of Amphibia, and of reptiles to the ganoids. Agassiz fully appreciated the more salient facts on which this generalization rests, and we may think it strange that it did not occur to him that the connection could only be explained by supposing that it was a genetic one.

In this respect Agassiz did not rise above the limitations of his time and of his own nature, but the facts he worked out, or which his students and collaborators discovered, were freely given to his students; and in this respect if he did not grasp, or was unwilling to accept, the conclusions of Lamarck and of Darwin, he paved the way for the adoption by his students of evolutional views.

How well does the writer remember a conversation he once held with Agassiz at Penikese, in the summer of 1873. We had given a lecture to our class on Limulus, the horseshoe crab, its structure and mode of development, at the close advocating without reserve the view that Limulus does not stand alone, but that it is genetically related to other jointed animals, and that there are different lines of development of life-forms. At the close of the hour, and after the class had scattered to the work tables, Agassiz, who had been present, strode up and down the room in a state of evident, though repressed, excitement, and then remarked to us with one of his most genial smiles on his lips: "I should have been a great fellow for evolution if it had not been for the breaks in the paleontological record." We replied: "But, Professor, see what great gaps in the higher vertebrates have been filled by the recent discoveries of birds

with teeth, and of Tertiary mammals connecting widely separated existing orders." And then, with a few more words, which we do not distinctly remember, we separated. Not a sign of displeasure during that August afternoon disturbed the genial and sweet nature of the great naturalist. He was not then, though occasionally so, dogmatic. The touch of bigotry, if we may use so strong a word, which existed in his, as it does in many an intense, eager, clear-minded spirit, did not then crop out, and it was one of the most delightful moments we ever spent with that eminently lovable man. Agassiz had then just passed his sixty-sixth year; and, after having for years combated the principle of evolution raised by Lamarck and by the author of the *Vestiges of Creation*, he did not, unlike his contemporaries Lyell, Wyman, W. B. Rogers, and others, change his views.

And so it is, in youth the older naturalists of the present generation were taught the doctrine of creation by sudden, cataclysmic, mechanical, "creative" acts; and those to whose lot it fell to come in contact with the ultimate facts and principles of the new biology had to unlearn this view, and gradually to work out a larger, more profound, wider-reaching, and more philosophic conception of creation.

AGASSIZ AND THE ICE AGE.

G. FREDERICK WRIGHT.

AGASSIZ did not claim to be the first one to see that the glaciers of the Alps formerly filled the valley of the Rhone in Switzerland and extended to the summits of the Jura Mountains. The credit of this brilliant theory he freely gave to his hospitable friend Jean de Charpentier, Director of Mines in the Canton of Vaud and living at Bex, a few miles above the head of Lake Geneva. Nor was the theory original with Charpentier. A mountaineer named Perraudin, living at the foot of the St. Bernard in Vallais, told Charpentier as early as 1815 that the large boulders along the sides of the Alpine valleys were left there by glaciers which once filled them. Fourteen years later, in 1829, an engineer named M. Venetz recalled to Charpentier the theory of Perraudin and advocated its truth. This belief of the Swiss engineer was defended in an essay read to the Swiss naturalists in 1821, but the paper remained unnoticed until Charpentier became a convert to the theory through the arguments of Venetz in 1829. The paper was not published, however, until 1833, the same year in which Charpentier's first paper on the subject was published.

But, although this paper of Charpentier presented the facts from the hands of a master, it did not convince Agassiz or many others. In 1836 Agassiz and his wife, however, accepted an invitation to spend their summer vacation with Charpentier at Bex, with the result that he returned to his home at Neuchâtel an enthusiastic advocate of the glacial theory. And well he might be, for he had himself been living among the most remarkable indications of glacial work that could anywhere be found in the world. The very soil beneath his feet was composed of the Alpine glacial grist. The whole valley was gridironed with moraines, while one of the largest known Alpine boulders, the *pierre à bot*, rested high up on the flank of the Jura Mountains, not far from Neuchâtel.

But, carefully as Charpentier had worked out his limited theory for the valley of the Rhone, he was not prepared for the far grander and more brilliant generalization which Agassiz was ready to propose. In an epoch-making address delivered at a gathering of naturalists at Neuchâtel on July 27, 1837, Agassiz propounded the theory that within a geologically recent period the whole northern hemisphere, as far down as the Mediterranean and Caspian Seas, had been covered with a vast sheet of moving glacial ice, maintaining that the glacial drift around Neuchâtel did not come from the Alps, but from the north.

Brilliant as was Agassiz's presentation of this theory, it astonished rather than convinced his hearers. Among these were Von Buch and Elie de Beaumont, two of the most influential geologists of the time, both of whom were fairly horrified by the seeming extravagance of the theory. Agassiz was then but thirty years old, and had strong hopes of being promoted to a professorship in some of the larger universities of Europe. The indorsement he had received from Cuvier and Humboldt amply justified him in such expectations. But whatever the prospects had been before, they were scattered to the winds by this address with its unfavorable effect on the minds of the influential naturalists who were present.

Even the warmest admirers of Agassiz would not contend that all portions of his theory as first presented were correct. He was mistaken in supposing that the ice which covered Switzerland had any of it come from the north. Charpentier was right in holding that the Alps constituted the centre of the whole glacial movement in that part of Europe. But Agassiz was correct in his belief that there had been a general refrigeration of the northern hemisphere which had profoundly changed both the plants and the animals of the whole region. The theory as propounded by Agassiz and afterwards verified by him is scarcely less grand, impressive, and revolutionary than was that of the Copernican system of astronomy, while the work of verifying, defending, and giving currency to the theory demanded scarcely less genius than that of its origination. But for this task also he was fully competent.

In 1838 he began that careful study of the Alpine glaciers which brought out most of the facts which have since convinced the world of the reality of the glacial period. With a party of six he ascended the valley of the Aar to the Grimsel Pass, and, upon his return after ten days, started at once for Chamounix, where the party was gone a week. With the additional facts gathered in these trips, Agassiz attended the meeting of the Geological Society of France at Porrentrui (Sept. 5, 1838), where he was more successful than the year before in convincing the sceptical of the truth of his theory. In August, 1839, Agassiz resumed his glacial studies, and, taking with him a number of eminent geologists, visited Monte Rosa and the Matterhorn, when, after studying the Gorner Glacier, he made a visit to the Aletsch Glacier and the Merjelen Lake, and thence went on to the Glacier of the Rhone, subsequently visiting again the Grimsel Pass and the Glacier of the Aar. As a result of this excursion, the most determined opponents of the glacial theory who accompanied him became convinced.

The characteristic respect which Agassiz paid to ordinary observers appears in a conversation of his with his guide to the Gorner Glacier. "Seeing a vertical wall of serpentine fineiy polished, he asked the guide to what that phenomenon was due. The guide, who had not the smallest interest in the glacial question, answered with great *naïveté* that in the country (*le pays*) everybody thought that it was made by the glacier, adding: 'It is true that no inhabitant of the village remembers to have seen the glacier in this place, but it was there formerly, for it is always in this way that the glaciers wear away the rocks.'"[1]

Upon this excursion Agassiz was taken by his guide to see the cabin upon the Glacier of the Aar which had been built and occupied by the monk Hugi of Soleure in 1827. Ten years later it was found that the cabin had moved downward with the surface of the glacier a distance of 2028 feet, or about 200 feet per annum. Agassiz resolved to return the next year and either reoccupy this cabin or build one for himself.

[1] *Life, Letters and Works of Louis Agassiz*, by Jules Marcou. New York, Macmillan, 1896. Vol. i, p. 145.

Meanwhile his observations had been already so complete that he felt himself justified in writing an extended work setting forth his glacial theories. This volume, entitled *Études sur les Glaciers*, was published in September, 1840, and was accompanied with eighteen beautiful plates. In the treatise explicit reference is made to the prior discoveries of Venetz and Charpentier, the work, indeed, being dedicated to them. Nevertheless, considerable ill feeling arose on account of this priority of publication.

In August, 1840, Agassiz returned to Hugi's cabin on the Glacier of the Aar with the intention of occupying it, but found that it had disappeared, there being only some of the *débris* remaining two hundred feet below the position occupied by it the year before. Whereupon Agassiz proceeded to build for himself a shelter under the projecting side of a huge boulder which was a prominent object upon a medial moraine. With this as the centre, he, with numerous colaborers, carried on for three successive summers those minute and careful observations upon glaciers which have been the basis of all subsequent speculation. In order to study the interior construction, they made deep borings into the ice, and on one occasion Agassiz was let down by a rope one hundred and twenty feet into a crevasse, while on another he spent a lonely night on the Siedehlhorn. To determine the rate of motion, he set a row of stakes across the glacier and took observations to determine their changes of position during an extended period.

While this work was in progress, Agassiz was visited by James D. Forbes, an English engineer of eminence, who spent some weeks with the party on the Aar Glacier in 1841. A year later Forbes returned to Switzerland and with his accurate mathematical instruments made observations upon the Mer de Glace sufficient to determine accurately the laws of its motion. A report of this was published by Forbes in the Edinburgh *New Philosophical Journal* in its issue for October, 1842. The report was dated, however, July 4, 1842. Meanwhile Agassiz had published the results of his observations upon the movements of the Aar Glacier in the *Comptes Rendus* of the 29th of August, 1842, two months before the publica-

tion of Forbes's letter. But Agassiz's report was dated twenty-seven days later than that of Forbes. Naturally enough, this complicated condition of things led to a spirited discussion as to priority of discovery. But there can be no question of Agassiz's originality in the matter. Without any reference to Forbes, he had, by his slow process of observing his stakes during a succession of years, determined that the central portion of the glacier moved faster than the portion near the side; for in 1842 the stakes in the middle of the glacier, set the year before, were one hundred feet farther down than those near the sides. On the other hand, Forbes has never been able to free himself from the suspicion of having unfairly availed himself of Agassiz's generous hospitality to copy his method and put it into execution at the earliest opportunity.

Having thus convinced the Swiss geologists that their own country had once been completely enveloped in glacial ice, the still more difficult task remained of extending the theory to other countries. The first opportunity for such extended observation offered itself during the autumn of 1840, when Agassiz attended the meeting of the British Association at Glasgow, when, during numerous excursions taken over the north of England, Scotland, and Ireland in company with Buckland and Lyell, he established the fact that all those regions had been deeply enveloped in glacial ice. Murchison, however, with many other eminent British geologists, continued to doubt the theory and to endeavor to explain the scratches on the rocks, the transportation of boulders, and the accumulation of moraines on the iceberg theory. During this visit Agassiz's quick eye saw the resemblance between the parallel roads of Glen Roy and such terraces as would naturally form around a glacial lake such as he had studied in the Merjelen Sea, on the border of the Aletsch Glacier.

Agassiz's last visit to the Glacier of the Aar was at the beginning of 1845, when he transferred his observations to Daniel Dollfus-Ausset, who faithfully continued them until 1861.

Agassiz, meanwhile, was approaching the great crisis of his life. Business failures broke up his work at Neuchâtel, and

he came to America in 1846 to give a course of Lowell Institute Lectures in Boston, which he had been invited to do upon the recommendation of Sir Charles Lyell. With imperfect knowledge of English he succeeded in holding immense audiences on the general subject of "The Plan of the Creation, especially in the Animal Kingdom." The course was a marked success, notwithstanding his unfamiliarity with the English language. But it was followed by one more to his liking, given in the French language, upon "Les Glaciers et l'Epoque Glaciaire." From this time on the incidental observations of the great naturalist upon glacial phenomena became a most important part both of his own work and of the general literature of the subject.

In 1848 Agassiz made his celebrated excursion to Lake Superior in company with a small party of Harvard College students and Boston gentlemen. In a remarkable volume, now difficult to obtain, which resulted from this expedition, there is to be found a great wealth of glacial observations made at every stage of the journey. It was indeed a grand verification of his original theory. In 1864 Agassiz made an extended excursion in Maine, and brought back an immense amount of material in support of his glacial theory. The *Atlantic Monthly*, in an article entitled "Glacial Phenomena of Maine," contains his report upon the moraines and eskers and kames which there so reminded him of similar phenomena in his native country. The abundant later literature upon the subject is little more than a commentary upon these original observations of the great promulgator of the glacial theory.

In 1865 and 1866 Agassiz made extended explorations in Brazil mainly in the interests of biological science. In a side trip, however, which he made amid great difficulties in the rainy season in the Province of Ceara, 4° south of the equator, he thought he discovered numerous medial, lateral, and frontal moraines at an elevation of only eight hundred feet above the sea. But it is supposed by later observers that he was misled by the resemblance to glacial phenomena which often arises in connection with the slow disintegration of granitic masses in which the residuary boulders sometimes have a close resem-

blance to those which are distributed by glacial transportation. But in a later tour, in 1871 and 1872, around South America and through the Strait of Magellan, his glacial observations were very extended and of the highest value.

Thus, when the end came, Agassiz had lived, not only to see his brilliant theory generally accepted in its main features, but himself to verify it in both hemispheres and in three of the great continental masses. When we remember that glacial studies were merely his avocation, occupying but the spare hours of one whose life was overcrowded with other work, our admiration both for the genius and the industry of this great man can find no adequate expression. His incidental work was really greater than that which is accomplished by the main efforts of most men. It is fitting that a glacial boulder from his native land should mark his burial-place in the cemetery at Mt. Auburn, where his body lies amid the glacial accumulations which he himself had made so luminous and so instructive.

OBERLIN, December 18, 1897.

AGASSIZ ON RECENT FISHES.

DAVID STARR JORDAN.

About 1827, when Louis Agassiz was some twenty years of age, a student in the University of Munich, Spix and Martius returned from their travels in Brazil, bringing with them a large collection of fishes.

Agassiz was then a favored student of Dr. Döllinger, resident in his house, where in his modest apartments he maintained his "little academy," "sleeping-room, fencing-room, museum, and laboratory all in one," and here he kept the collection of fish skeletons which the anatomist Meckel once came all the way to Munich to see. He had already studied the structure and breeding habits of the fishes of Lake Neuchâtel, and his reputation was established as a man that knows fishes.

The collection of Spix and Martius was placed in Agassiz's hands, to be treated according to the best methods of systematic zoology. This the young man did to the best of his ability, taking the classic writings of Bloch and Lacépède as his model, and doing with his material quite as well as these fathers of ichthyology could have done.

The *Piscium Brasiliensium*, published in 1829, made a large, thick quarto, on heavy paper, with detailed descriptions and colored full-page illustrations of each species. The engravings were poor and costly, after the fashion of the time, and the descriptions elaborate, but uncritical, being formed after bad models before good models existed.

Criticism and comparison in zoology was first introduced by Cuvier, and most of Cuvier's descriptive work was in 1827 still in the future, though numerous references in the text to letters from Cuvier show that Agassiz had tried to make the best use he could of the help of his master.

A number of papers on the fresh-water fishes of Switzerland and neighboring regions were published in following years, —

worthy fruits of Agassiz's professorship in Neuchâtel. Those on the Salmonidæ treated largely of problems of development, at once most difficult and most interesting. Others took up the classification of the complicated family of Cyprinidæ (carp, chubs, dace, and minnows), with an attempt to divide the group into genera founded on natural — that is, anatomical — characters.

Similar attempts were made at about the same time by John J. Heckel and by Charles Lucien Bonaparte with much the same results. On the whole, Agassiz's work was the more successful as well as earlier in time.

For a number of years the fossil fishes and the glaciers occupied most of Agassiz's scientific activity.

In 1846 he came to America, accepting a chair in Harvard College, and was soon engaged in exploring the natural products of the New World, to which he "came in the spirit of adventure and curiosity," and in which he stayed "because he liked the land where he could think and act as he pleased; the land where nature was rich, while tools and workmen were few, and traditions none."

In America he soon renewed his interest in the fishes. In 1850 he published his volume on Lake Superior, which contained among other things an account of the fishes collected by himself and his students in a summer's trip of exploration.

In this volume, which is accompanied by excellent stone engravings, we see more of Agassiz's tendency to philosophic discussion. A remarkable new species, Percopsis, the type of a new family of ancient lineage, suggests to him many thoughts as to the succession of forms among fishes, though he was still unprepared to see in this a genetic relation. The descriptions of species in this book are very detailed, but not at all critical. They seem like the work of students, as they doubtless were, for whoever was in Agassiz's company was always set to work along the line of his thoughts. Agassiz's own best work was not in the line of description, but rather in suggestion. He had a keen eye for generalization, as for comparison and classification. His later papers on fishes were of the nature of syllabi and suggestions rather than of finished work, but they

play a very large part in the history of the systematic zoology of North America.

One of the most important of these was a critical study of the fauna of the Tennessee River, published in 1854, and based chiefly on collections made by Mr. Newman at Huntsville, Ala. In this paper he discussed certain problems of the distribution of fresh waters and indicated new ones. If he had answered these by inductive observation, he would have been led, as his students have been, at once into the belief in the transmutation of species.

In 1855 a collection of fishes from the western parts of the United States led him to a consideration in detail of the proper classification of our fresh-water fishes. Most of the many genera here proposed by him have stood the test of time, but in a few cases the true relation of forms was not fully understood. At about the same time, Dr. A. C. Jackson, of San Diego, called the attention of Professor Agassiz to the group of viviparous surf fishes (Embiotocidæ) which constitutes the most remarkable feature of the fish fauna of California. Agassiz took up the study of this group, described many of its genera and species, and gave an interesting account of its remarkable anatomical features. At almost the same time the same peculiarities were independently studied by Dr. W. O. Gibbons, of Alameda, and by Dr. Charles Girard, of the Smithsonian Institution, himself one of Agassiz's students. Agassiz's papers have priority of date, and the generic names given by him, especially the type name of Embiotoca, this word an inspiration in itself, are in general the ones to be retained.

After 1855 no papers of importance relating to fishes were published under Agassiz's own name. We find the influence of his views and example in the work of his students, notably Girard, Putnam, and Garman, as well as in that of Baird, Storer, and others who were indebted to him in one way or another for assistance.

Concerning the vast wealth of his Brazilian and other South American collections, Agassiz has written little. The basement of the museum at Cambridge is still crowded with unstudied material collected by Agassiz. Much of this material has been

investigated by Steindachner, Garman, Eigenmann, and the present writer, but with all that has been done there remains a residue rich in undescribed species.

Although the study of recent fishes was only a minor incident in Agassiz's multifarious activities, it was a branch in which he felt the deepest interest. His keen and broad insight helped him to bring its chaos into order, and his name deserves a large place in the history of systematic ichthyology.

With all his acumen, Agassiz was never able to correctly interpret the facts of the succession of the fishes. He said to me in 1873: "At one time (about 1842) I was on the verge of anticipating Darwinism, but I made up my mind at last that progress by transmutation of species could not be, because we had our highest fishes first."

Of course this is true in a sense, because the ganoid fishes are beyond a doubt nearer to the higher vertebrates than the recent fishes are, and the early sharks are in some regards (brain, reproductive system, alimentary canal, and teeth) more highly developed than is the case with the true or modern fishes. But neither of these facts, as we now understand, bears on the real question. The ganoid fishes constitute a synthetic or generalized type, from which at least two great lines of descent have sprung. From the double-breathing or amphibious ganoids we have descended the Batrachia, who pass through the fish-like or water-breathing stage as a phase of youth. From these come the Reptilia, who pass through their fish-like stage in embryo. And from Reptilia come the warm-blooded mammals and birds. The other great line of descent remains aquatic and fish-like. Its line of specialization has been to make its members more and more intensely *fish*. The purely aquatic life demands not higher development, but adaptive or "fish-like" structure. The typical recent fish loses its amphibian possibilities very early in life, and its development is along the lines of the demands its fish life is to make. In the abstract a modern fish is not "higher" than its ancient ganoid ancestors; nor is it properly in most respects lower. It has diverged and is become specialized and adapted to its condition in life. Adaptation, not progress, is the meaning of organic evolution.

AGASSIZ'S WORK ON FOSSIL FISHES.

CHARLES R. EASTMAN.

WHATEVER advances have been made in the science of paleichthyology since the time of Louis Agassiz, it is a significant fact that they have been rendered possible almost solely as the result of Agassiz's own researches. The position that Agassiz holds in the history of the science is that of founder, of extraordinarily acute and painstaking observer, of careful and sagacious systematist. If he was the first to place the study of paleichthyology upon a truly scientific basis, so, too, his contributions to this subject greatly preponderate over those of any other author. And not only was the knowledge of fossil fishes vastly increased by means of his writings, but, both directly and indirectly, he stimulated other investigators to pursue kindred lines of research.

It was especially fortunate that Agassiz should have been led to take up the study of fossil fishes when he did, for the reason that he possessed a more extensive knowledge of recent forms than probably any other savant in Europe with the exception of Cuvier, who unhappily did not live to see even the inception of the *Poissons Fossiles;* and also because there existed in the different museums at that time a large array of material, eminently suited for comparative investigation, and waiting only for a monographer. Without the wide experience in zoology and anatomy that Agassiz had already enjoyed, without his powers of penetration, of fine discrimination, and excellent judgment, it is safe to say that no one could have prepared a well-digested account of so much new material, nor have made clear the structure and relationships of such fragmentary remains. Genius, without training, could not have accomplished the masterwork which Agassiz performed, but the value of a trained scientific imagination was most forcibly illustrated in his case.

The circumstances which led Agassiz to enter upon the study of paleichthyology were largely fortuitous. When a student at Heidelberg, being then scarcely twenty years of age, he attended a course of lectures on paleontology by Professor Bronn, a teacher of profound erudition, and for whom he always entertained feelings of the warmest regard. The first portions of Goldfuss's great work, *Petrefacta Germaniae*, were then just issuing from the press, and awakened a sensational interest in geology and paleontology. The highly fossiliferous rocks of southern Germany were eagerly searched by collectors, and large gatherings found their way into the principal museums. Munich in particular became the repository of those exquisitely preserved remains which have made the name of Solenhofen famous in the annals of paleontology for all time. And thither, to Munich, Agassiz came before he was twenty-one, yet not without having made the acquaintance of almost every large-sized collection in the land. To use his own words, as given in a brief account of his university life, "I knew every animal, living and fossil, in the Museums of Munich, Stuttgart, Tübingen, Erlangen, Würzburg, Carlsruhe, Heidelberg, and Frankfort."[1]

The project of preparing a general work on fossil ichthyology seems to have first taken shape in his mind while a student at Heidelberg; its feasibility was impressed upon him after an examination of the above-mentioned collections, and on receiving numerous friendly offers for the loan of specimens; and its initiation dates from the period of his removal to Munich, if we may judge from a letter written to his brother in January, 1830, from which we quote as follows:

> Having by permission of the Director of the Museum one of the finest collections of fossils in Germany at my disposition, and being also allowed to take the specimens home as I need them, I have undertaken to publish the ichthyological part of the collection. Nowhere so well as here, where the Academy of Fine Arts brings together so many draughtsmen, could I have the same facility for completing a similar work; and as it is an entirely

[1] *Louis Agassiz, His Life and Correspondence*, by E. C. Agassiz. Boston, 1885. Vol. i, p. 157. On the growth of some of these institutions and the influence of Bronn and others, see an article by K. A. von Zittel, in *American Geologist*, vol. xiv, 1894, pp. 179–185.

new branch, in which no one has as yet done anything of importance, I feel sure of success; the more so because Cuvier, who alone could do it (for the simple reason that every one else has until now neglected the fishes), is not engaged upon it. . . . Now that I have it in my power to carry out the project, I should be a fool to let a chance escape me which certainly will not present itself a second time so favorably.

Three years after the date of this letter the first *livraison* of his immortal *Poissons Fossiles* appeared, the publication of which in five large quarto volumes, illustrated by nearly four hundred folio plates, extended over the interval from 1833 to 1844, and was followed by a supplementary volume, entitled *Monographie des Poissons Fossiles du Vieux Grès Rouge ou Système Devonien (Old Red Sandstone)*, with an atlas of thirty-three plates, in 1844–45.[1]

The author's work on this "vaste publication" was embarrassed by difficulties of the most aggravating nature. There were first of all the exacting terms imposed by his publisher, Cotta of Stuttgart, who eventually withdrew from the undertaking as being too expensive; and afterwards the financial hazard involved in the maintenance of a private printing establishment. The restrictions of many museum authorities relative to the transportation of specimens proved also a serious hindrance, necessitating as it did a journeying about on the part of himself and an artist until he had ransacked every collection worthy of the name in Europe. To say nothing of the personal expense and labor he was subjected to by this plan, it was unsatisfactory for yet another reason, to which he refers as follows in the preface to his *Poissons Fossiles:*

Notwithstanding the cordiality with which even the most precious specimens have been placed at my disposition, a serious inconvenience has resulted from this mode of working; namely, that I have rarely been able to compare directly the various specimens of the same species from different collections, and that I have often been obliged to make my identification from memory, or from simple notes, or, in the more fortunate cases, from my drawings alone. It is impossible to imagine the fatigue, the exhaustion of all the faculties, involved in such a method. The hurry of traveling, joined to the

[1] For the actual dates of publication of the various parts and plates, see the list compiled by W. H. Brown, and prefixed to the *Catalogue of British Fossil Vertebrata*, by A. S. Woodward and C. D. Sherborn (London, 1890), pp. xxv–xxix.

lack of the most ordinary facilities for observation, has not rendered my task more easy.

The incidents that befell him while prosecuting his researches; the friendships he formed with all the distinguished scientists of the day; the favorable impression he everywhere created, especially in Britain, where his fame had preceded him; the influence of Humboldt and Cuvier upon his career; his prodigious energy, enthusiasm, and devotion to his chosen purpose; the personal qualities drawn out by the struggles and hardships he endured; his gratification at the final acknowledgment of his success, — all these are topics which have been abundantly treated of by his biographers. It remains for us merely to call attention to some of the more general features of his work on paleichthyology. But here, too, it will be difficult at this day for one to offer anything novel, since during the last half-century it has been frequently and ably reviewed.

We can only add our tribute, in a word, that the publication of the *Poissons Fossiles* laid the foundation of a new science, and reared at the same time a large portion of its superstructure. This work also marked an epoch in the history of paleontology and zoology in general, since one of its brilliant results was the discovery of certain comprehensive laws, which are now admitted to be of fundamental importance. Without doubt the most far-reaching of these in its consequences is the analogy which he pointed out between the embryological phases of recent fishes and the geological succession of the class; whereupon he deduced the generalization, "The history of the individual is but the epitomized history of the race." Another notable result was the recognition and characterization of his so-called prophetic or synthetic types, that is, such as embrace features in their organization which afterwards become distributed among a number of groups, and are never recombined. Incidentally, or rather as a corollary to the preceding, he introduced a new method of studying animal types; namely, that of testing zoological results by embryological investigations, and, similarly, embryological by paleontological. He insisted that the comparative anatomy of a group, including its paleontological record, should be studied in connection with the comparative

embryology of the same; in fine, as he says, "The results of these two methods of inquiry complete and control each other."

In this memoir Agassiz also worked out the geological succession and distribution of the different groups of fishes, thereby greatly increasing the practical value of their remains as an aid in identifying strata. His observations upon the heterocercal tail, its duration in time, and, owing to accelerated development, its transitory appearance in the early stages of recent forms deserve notice in this connection. The principles of tachygenesis seem to have been fully grasped by him, although not distinctly formulated. To him properly belongs the credit, also, according to the testimony of one of his students at a later date,[1] of having first apprehended and expounded what is commonly called the biogenetic law of Haeckel.

Yet another important feature of the *Poissons Fossiles* was the proposal of an entirely new system of classification of fishes, fossil and living, based upon the different types of scales, which were found to coincide to a remarkable degree with certain skeletal differences. His system was the first to recognize the ganoids as an independent order, although it is true that the limits assigned it were much larger than we can at present allow. However, Agassiz did not himself overestimate the value of his classification, being fully aware of its empiric character; but he committed himself to it chiefly on account of its great practical convenience. His aim was quite as much to prove the succession of fossil fishes throughout the different geological horizons as to work out their anatomical structure; and for this purpose, as well as for enabling him to bring together in an intelligible order large quantities of fragmentary material, it succeeded admirably. It may not be amiss to cite in this connection a letter of his to Humboldt, in which he disclaims attaching any special importance to his classification, and con-

[1] *Cf.* Alpheus Hyatt, On Cycle in the Life of the Individual (Ontogeny), and in the Evolution of its Own Group (Phylogeny). *Science*, N.S., vol. v (1897), pp. 161–171. Hyatt considers that "Agassiz's introduction of the element of succession in time laid the basis for all more recent [embryological] work" (p. 163).

tinues as follows: "My object was only to utilize certain structural characters which frequently recur among fossil forms, and which *might therefore enable me to determine remains hitherto considered of little value*." [1]

Lastly, the *Poissons Fossiles* is notable for still constituting the most valuable repository of information we have on fossil fishes. In it are enumerated more than one thousand species, the greater part of which are accurately described and magnificently illustrated; and it is worth recording that the first successful application of chromolithography was in the execution of these plates. The fidelity of the drawings to nature and the minuteness of the accompanying descriptions have never ceased to challenge wonder and admiration.

Passing now for a moment to Agassiz's supplementary volume on the *Fishes of the Old Red Sandstone*, one cannot but feel amazement at the accuracy, cleverness, and originality of the author as displayed throughout this truly wonderful work. Greater difficulties were encountered in the way of studying the remains, which were scanty at best and imperfectly preserved; and more intricate problems presented themselves respecting the anatomy and homology of parts than any he had met with in the preparation of his larger work. True, the discovery of the Ludlow and Cromarty faunas was not a matter of long standing, but it had already engaged the attention of the most eminent British geologists and paleontologists, who were one and all confounded over the problematical organisms. But whether as a result of his training or intuition, or both, Agassiz had no hesitation in declaring, the moment he examined one of Hugh Miller's drawings and description of Pterichthys, that the creature was a chordate, and belonged to the class of fishes. His astonishment, however, on first seeing the actual fossils, is well told by himself in the preface to his monograph, as follows:

> I can never forget the impression produced upon me by the sight of these creatures, furnished with appendages resembling wings, yet belonging, as I had satisfied myself, to the class of fishes. . . . It is impossible to see aught more bizarre in all creation than the Pterichthyean genus; the same aston-

[1] E. C. Agassiz, *loc. cit.*, p. 203.

ishment that Cuvier felt in examining the Plesiosaurus I myself experienced when Mr. H. Miller, the first discoverer of these fossils, showed me the specimens which he had collected in the Old Red Sandstone of Cromarty.

Any one who has attempted for himself to decipher the distorted and for the most part obscure remains from the Scottish Old Red can imagine the difficulties which the first students of such extraordinary forms labored under. He will understand that above all scrupulous refinement of observation is necessary; that innumerable comparisons and attentive reëxaminations of even the most tattered fragments must be made in order to test his hypothesis of the association of parts. Considering the means at Agassiz's disposal, his work must be pronounced nothing short of brilliant; it was remarkable alike for the originality and insight displayed, and for the general correctness of his conclusions. That some of his generalizations should have been premature was an inevitable consequence of pioneer work. And if, after more than fifty years, certain of his views are found to require modification, or to be no longer tenable, what more was to have been expected?

To cite one or two instances by way of illustration, let us suppose we grant with Cope that the Ostracodermi are not fishes, properly speaking, but belong to a group at the base of the craniate Vertebrata, characterized by the lack of a lower jaw and of paired limbs; how does that detract any from the unerring judgment of Agassiz, who pronounced them first of all to be chordates, and assigned them a place among the most primitive of ganoids? If we criticise his restorations of Pterichthys and Coccosteus as being crude and fanciful, we cannot accuse him, at all events, of misrepresentation. Just as it required the genius of a Traquair after many years of patient study to prove that the Platysomidæ are in no sense whatsoever related to the pycnodonts,[1] so, too, it required the combined efforts of the best Russian, German, and British talent to unravel the complicated structure of the coccosteids and ostracoderms. Tremendous advances have since been made, almost as a matter of course, but it was Agassiz who first clearly

[1] R. H. Traquair, On the Structure and Affinities of the Platysomidæ. *Trans. Roy. Soc. Edinburgh*, vol. xxix, 1879, pp. 343-391.

pointed out the way. Again, if it be said that Agassiz created numerous species on too slender grounds of distinction, does not this merely express the refinement of his personal equation in the art of discerning differences between allied forms of organisms, for which compensation is easily possible?

Aside from the classic works just noticed, Agassiz contributed very little to the subject of paleichthyology. A few minor papers appeared in different journals, or were appended to geological monographs by other authors (Murchison, de Verneuil, Keyserling, etc.), prior to his departure for America. In this country his attention was so diverted in other directions that he was unable to prosecute further original investigation. Some informal reports on fossil fishes were prepared by him at the meetings of the American Association for the Advancement of Science (at one of which, the Cincinnati meeting, in 1851, he offered some surprising comments on Macropetalichthys), and brief notes on the fishes of the Virginia Coalfield were contributed to Lyell's account of the geology of the basin in 1847. With these exceptions, the only paper from his pen on fossil fishes in America is that appended to the fifth volume of the Pacific Railroad Surveys,[1] published in 1856. It is also rather remarkable that he succeeded in interesting only one student of his to take up this line of research seriously; this was Mr. Orestes St. John, well known from his writings on Carboniferous fishes from Illinois and other western states.

Many have wondered why Agassiz, with all his wealth of information, his fertility of imagination, and after having discovered the very laws which constitute so important a bulwark in the theory of evolution, should persistently have opposed that doctrine, although his work on fossil fishes prepared the way for it most admirably. There can be no doubt that his mind was closed to such conclusions through the influence of preconceived ideas, on which it is unnecessary for us to dwell. His position with reference to the evolutionary hypothesis has been

[1] Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean. *Report of Explorations in California*, by Lieut. R. S. Williamson, vol. v, Washington, 1856. (Abstract of Agassiz's article in *Amer. Journ. Sci.* [2], vol. xxi, 1856, p. 274.)

so fittingly summarized by Le Conte [1] that we cannot do better, in conclusion, than heartily to indorse the following sentiments:

"There is something to us supremely grand in this refusal of Agassiz to accept the theory of evolution. The opportunity to become a leader of modern thought, the foremost man of the country, was in his hands, and he refused, because his religious, or perhaps better, his philosophic intuitions forbade. . . . A lesser man would have seen less clearly the higher truth, and accepted the lower. A greater man would have risen above the age, and seen that there was no conflict [between the theory of descent and still more certain truth], and so accepted both."

[1] Joseph Le Conte, *Evolution and its Relation to Religious Thought*, p. 45. New York, 1888.

AGASSIZ'S WORK ON THE EMBRYOLOGY OF THE TURTLE.

GERTRUDE C. DAVENPORT.

AGASSIZ'S *Embryology of the Turtle* — the second volume in the series of *Contributions to the Natural History of the United States of America* (1857) — was for its time, and still remains in these days of refined histological technique, a beautiful and useful research. The scope of the book is broad. Stages in the development of the turtle are described, beginning with the most immature eggs in the ovary and continuing through many embryonic phases until the young turtle hatches out.

In addition to the great contribution to embryological knowledge which this book brought, it also contained much information of a sort too often unobserved or omitted by embryological investigators of to-day; namely, the habits, especially the breeding habits, of the animals studied.

Even to the present time we have almost no other printed accounts and none so complete to which we can turn for information in regard to the breeding time of and the number of eggs deposited by our commoner American turtles. Indeed, until Agassiz's time, and even to-day, it is believed by many that turtles lay in the fall as well as the spring. By careful observation upon turtles kept in comparative freedom and upon those in a wild state, Agassiz found that turtles deposit eggs once a year, normally in the months of May and June, the time depending upon the kind of turtle in question. Moreover, he determined the age at which various kinds of turtles begin to lay eggs and the time necessary for their hatching. These are only a few of the many interesting and useful facts regarding the life history of the turtle which this volume contains.

Agassiz's studies of ovarian eggs likewise disclosed many new facts. For example, the period of growth of ovarian eggs was determined. Ovarian eggs develop in sets corresponding in number to that of each laying. From the size and appearance of these ovarian sets, Agassiz was able to say

positively in what order at least four of the sets would be laid. His studies of ovarian eggs were, on the whole, excellent for his time, but his ideas in regard to yolk spheres differ considerably from those held to-day.

For our knowledge of segmentation stages we are indebted to Agassiz alone. Although the segmentation stages drawn in his beautiful plates or described by him do not form a complete series, nevertheless they remain the only ones observed by reptilian embryologists.

The next stage figured and described is that now generally known as the stage of the embryonic shield. The figures of this stage are beautiful and accurate, but what is now known to be the invagination of the primitive gut was mistaken for the beginning of the head development; in other words, the posterior end of the shield was mistaken for the anterior end.

Many individuals and stages in the subsequent embryological development are figured, and helpful descriptions of surface views are given. Those figures showing the vitelline and allantoidian circulations deserve especial mention.

The chapter and figures devoted to the development of organs contain much that is still useful to us. Indeed, his results are marvelous when we compare the methods of investigators of that day with those of our own. For we must remember that in Agassiz's time, imbedding in paraffin, the microtome, and, consequently, methods of reconstruction from sections were unknown. On the other hand, this absence of modern technique renders the chapter devoted to histology, however good for its time, of little scientific value for us to-day.

Eight plates are devoted to figures of the eggs and recently hatched embryos of all the commoner North American species of turtles. So accurately are these drawn that one can with certainty identify the species from the egg or newly hatched young. These plates alone render the work indispensable.

It is a tribute to the zeal and thoroughness of Agassiz and his helpers in this work that after forty years it stands to-day with its many unverified facts as an incentive to the reptilian embryologist to confirm and extend the work so magnificently begun.

AGASSIZ AT PENIKESE.[1]

BURT G. WILDER.

ELSEWHERE are set forth the characteristics and the achievements of Louis Agassiz as investigator and director of research, as accumulator of specimens and builder of museums, as writer and public lecturer. Whatever has been said of him also as inspirer of lofty effort and personal sacrifice, as teacher, and educational pioneer, surely the precious qualities implied in these terms were never more conspicuous or more effective than during the last year of his life in the establishment of the Anderson Summer School of Natural History at Penikese Island.

On the 14th of December, twelve months to a day before his death, was issued a circular embodying a "Programme of a Course of Instruction in Natural History, to be delivered by the Seaside, in Nantucket, during the Summer Months, chiefly designed for Teachers who propose to introduce the Study into their Schools and for Students preparing to become Teachers."

The following extract from a later circular clearly indicates the founder's views as to the nature of the enterprise:

[1] This article is based upon the writer's diary and recollections, and upon his article, "The Anderson School of Natural History," in the *Nation* for Sept. 11, 1873, pp. 174, 175. The doings of the first two days were described by a staff correspondent in the *New York Tribune* for July 9 and 10, 1873. In the *Popular Science Monthly*, vol. xl, pp. 721–729, April, 1892, under the title "Agassiz at Penikese," are recorded the impressions of the entire session upon a pupil, David S. Jordan. *The Organization and Progress of the Anderson School of Natural History at Penikese Island* (30 pp. and 5 ppl., Cambridge, 1874) is the "Report of the Trustees," of whom one was Alexander Agassiz, the professor's son; as a clear and accurate record of the essential facts it could not be surpassed. In *Louis Agassiz, His Life and Letters* (2 vols., Boston, 1885) Mrs. Agassiz has devoted the larger portion of the last chapter to what another biographer has characterized as "the most extraordinary episode in Agassiz's life." Upon the present occasion, under the necessary limitations of space, rather than a mere outline of the whole, the writer has endeavored to describe a few incidents that seem to him most characteristic of the occasion and of the man.

I must make hard work a condition of a continued connection with the school, and desire particularly to impress it upon the applicants for admission that Penikese Island is not to be regarded as a place of summer resort for relaxation. I do not propose to give much instruction in matters which may be learned from books. I want, on the contrary, to prepare those who shall attend to *observe for themselves*. I would therefore advise all those who wish only to be taught natural history in the way in which it is generally taught, by recitations, to give up their intention of joining the school.[1]

In the following spring the munificent offer by an utter stranger, Mr. John Anderson, of New York, of the island of Penikese in Buzzard's Bay, together with a dwelling-house and barn and an endowment of fifty thousand dollars, not only led to the change of location, but enabled Agassiz to carry out certain parts of his plan more fully.

The island was not formally in possession until April 22. Between that date and the 8th of July, when the school was announced to open, a site for buildings had to be chosen, plans drawn, contracts let, and provision made for the housing and subsistence of nearly fifty pupils and several instructors, some of them with families.

Notwithstanding the utmost efforts of all concerned, on the 5th of July, when Professor Agassiz and the writer reached the island, only one of the two projected buildings had been even roofed; it was neither floored nor shingled. The next day was Sunday. A few words from Agassiz satisfied the carpenters as

[1] The passages quoted above, and many that might be added from the circulars of Professor Agassiz, from his opening addresses, and from private letters and conversations, demonstrate conclusively that, while anticipating as an indirect result the increase of knowledge by research upon the part of the instructors and advanced pupils, the *primary object was instruction in fundamental facts, ideas, and methods;* he repeatedly declared his hope that the Anderson School might become the "educational branch of the Museum of Comparative Zoology." Whatever may have been his dreams for the future, and however extravagant may have been the declarations and prognostications in uninformed lay journals, at that time nothing was farther from his mind than any comparison with, *e.g.*, the Zoological Station at Naples. The fact of his clear recognition of the distinction is insisted upon here in the interests of simple justice towards Professor Agassiz, his associates, and pupils. Those who may regard this insistence as needless are referred to the article "An American Seaside Laboratory" in *Nature* for March 25, 1880, pp. 497–499, and to the commentary thereon, "The Penikese School," in the *Nation* for July 8, 1880, p. 29.

to the application of the proverb, *Laborare est orare*, and they worked from daylight till dark. On Monday (for the steward and servants were to come with the pupils) the floor was swept, and Tuesday morning the beds were made by Mrs. Agassiz and the writer's wife. That morning, also, the cows were removed from Mr. Anderson's barn; the last nails of a new floor were hardly driven when the steamer arrived, and in that room, still hung with spider webs and frequented by the swallows, were delivered the inaugural address and eaten the first dinner at Penikese.

The invitation of Professor Agassiz to coöperate in the work of the school had been accepted by about twenty, and it is pleasant to note that, with hardly an exception, their services were freely offered, although liberal arrangements were afterwards made with those who, in addition to Professors Agassiz and Guyot and Count Pourtalès, actually gave instruction. These were Edwin Bicknell, T. I. F. Brewer, B. Waterhouse Hawkins, A. S. Packard, Paulus Roetter, and the writer.

The roll of pupils is printed on pages 19–20 of the *Report of the Trustees* for 1874; it is here reproduced, alphabetically arranged, and with the addition, in parentheses, of the present official positions so far as known to the writer. Those known to have died are indicated by an asterisk.

ADAMS, CH. F., Teacher in High School, Fitchburg, Mass.
APGAR, A. C., Teacher in State Normal School, Trenton, N. J.
BEAMAN, MARY E., Teacher in High School, Binghamton, N. Y.
BOWEN, SUSAN, Teacher in Mount Holyoke Seminary, South Hadley, Mass.
BROOKS, W. K., Teacher, Cleveland, Ohio (Professor of Zoology in Johns Hopkins University).
BURNS, Mrs. V., Teacher in Public School, Pittsburg, Pa.
CLAYPOLE, E. W., Professor at Antioch College, Yellow Springs, Ohio (Professor of Natural History, Buchtel College).
COFFIN, HELEN B., Teacher in Eastern State Normal School, Castine, Me.
COLE, CAROLINE J., Teacher in State Normal School, Salem, Mass.
COOK, S. R., Teacher in Packer College Institute, Brooklyn, N. Y.
CROSBY, EUGENE C., Teacher, Kansas City, Mo.
CROSBY, W. O., Student in Boston School of Technology (Assistant Professor of Geology, Massachusetts Institute of Technology).
DAVIS, MARY E., Teacher in High School, East Somerville, Mass.

FAXON, WALTER, Instructor in Museum of Comparative Zoology, Cambridge, Mass. (Assistant in charge of the Museum).

FERNALD, CH. H., Professor, Maine State College, Orono, Me. (Professor of Zoology, Massachusetts Agricultural College, Amherst).

FEUKES, J. WALTER, Student at Harvard College, Newton, Mass. (Zoologist and Ethnologist, Washington, D. C.).

GARMAN, S. W., Museum of Comparative Zoology, Cambridge, Mass. (Assistant in Herpetology and Ichthyology in the same).

GASTMAN, E. A., Superintendent of Public Schools, Decatur, Ill.

HALE, SILAS W., Principal of High School, Milford, Mass.

HALL, CHARLES E., State Museum of Natural History, Albany, N. Y.

HANSON, M. ISABEL, Newton Training School, Newtonville, Mass.

HOLMAN, LAVINIA, Teacher in Normal School, New York City, N. Y.

HOOPER, F. W., Student at Harvard College, Walpole, N.H. (Director of Brooklyn Institute).

INGERSOLL, ERNEST, Museum of Comparative Zoology, Cambridge, Mass. (Ornithologist and Author).

IRELAND, CATHERINE, Teacher of Private School, Boston, Mass.

JOHNSON, AMY, Teacher in Brooks Seminary, Poughkeepsie, N. Y.

*JOHONNOT, JAMES, Teacher in State Normal School, Warrensburg, Mo.

JOHONNOT, MARION, Teacher in State Normal School, Warrensburg, Mo.

JORDAN, DAVID S., Instructor in Botany, Appleton, Wis. (President of the Leland Stanford Junior University).

MILLER, A. B., Teacher in Maplewood Institute.

MINOT, CHARLES S., Zoological Student, Jamaica Plains, Mass. (Professor of Histology and Human Embryology, Harvard Medical School).

MOSES, THOMAS F., Teacher of Natural Science, Urbana, Ohio (Professor of Natural History, Urbana University).

REID, ZELLA, Antioch College, Salem, Ind.

SCOTT, J. G., Teacher in Normal School, Westfield, Mass.

SHATTUCK, LYDIA, Teacher in Mount Holyoke Seminary, South Hadley, Mass.

SMITH, SARAH R., Teacher in Chauncy Hall School, Boston, Mass.

STOWELL, T. B., Professor in State Normal School, Cortland, N. Y. (Principal of the State Normal School, Potsdam, N. Y.).[1]

*STRAIGHT, H. H., Teacher in State Normal School, Warrensburg, Mo. (Professor of Natural History, State Normal School, Oswego, N. Y.).

*STRAIGHT, Mrs. EMMA, Teacher in State Normal School, Warrensburg, Mo.

TINGLEY, J., Teacher in Alleghany College, Meadville, Pa.

WHIPPLE, ELLIOT, Principal of Academy, Bunker Hill, Ill.

WHITE, MARY R., Teacher in Training School, New Bedford, Mass.

[1] Although not registered as a student, Mrs. T. B. Stowell accompanied her husband and coöperated efficiently in his work.

WHITMAN, C. O., Teacher in English High School, Boston, Mass. (Head Professor of Biology, University of Chicago, Ill.).
WHITNEY, SOLON, Teacher in Cambridge High School, Watertown, Mass.

It is significant that at least six of those who attended the first summer school of natural history in America have been more or less directly concerned in the development of its improved successors in various parts of the country.

Of the forty-four persons on the above list, sixteen — more than one-third — were women. Coeducation — then hotly debated and regarded in some quarters as a bugbear — had not, apparently, with Agassiz even the dignity of existence as a problem. In his opening address the matter was disposed of in the following words:

> As soon as the number of students was limited, we determined a question of no small moment, — whether ladies should be admitted. In my mind I had no hesitation from the start. There were those about us whose opinion I had to care for but did not know, so I thought the best way was not to ask it, but to decide for myself.

His decision was certainly consistent. The title of his thesis at graduation in 1830 was "*Femina humana mari superior.*"[1] For several years he had lectured almost daily in a school for girls conducted by his wife; and upon her intellectual companionship and coöperation he had become so dependent that he once declared to the writer with signs of profound emotion, "Without her I could not exist." Nor was his confidence in the desire and capacity of those women misplaced. With hardly an exception, their assiduity was notable, and they, rather than the men, required warning against overwork during what should have been their time of rest or recreation.

The age and position of most of the students and the circumstances under which they were placed precluded any expectation of disorder. The single untoward incident is mentioned as illustrating two of Agassiz's characteristics, *viz.*, his hopeful willingness to afford individuals the benefit of any

[1] So stated in Guyot's *Memoir of Louis Agassiz*, p. 17. Read before the National Academy of Sciences, 1877 and 1878. Princeton, 1883. 49 pp.

doubt in their favor and his clear perception of the injustice of permitting an institution to suffer from the presence of such as prove unworthy of confidence. Among the men first admitted were three whose ancestry led Agassiz to overlook their youth and lack of experience as teachers. Early in the session they committed a breach of decorum which some might regard as amusing or as exemplifying the infallibility of the comfortable doctrine, "Boys will be boys." The next morning Agassiz simply announced that three young men had shown themselves undeserving and would leave the island before noon. What an object lesson in disciplinary methods for timid faculties!

The pupils, of whom, it will be remembered, nearly all were themselves teachers of more or less experience, proposed to form an "Agassiz Natural History Club" for mutual benefit. The instructors were invited to attend as honorary members. At one of the earlier meetings an afternoon was spent in elaborating a constitution, electing officers, etc. Agassiz sat silent and apparently motionless, but those nearest him could detect signs of increasing impatience, and when invited to address the club he spoke substantially as follows:

Gentlemen, — I had heard that Americans are famous for the perfection of their organizations, and of course order must be maintained in every association. But at best officers and by-laws are necessary evils. We shall not be many days together; surely part of this afternoon might have been better spent in the reading and discussion of papers. At any rate, that is what we should have done in Switzerland.

At the close of another meeting of the society Agassiz remained seated for some time as if reflecting, and when at length he rose and moved away it was with unwonted deliberation. On being questioned he replied, "I sat so long because I was not sure that I could walk. At times I realize that I am growing old and that I have not always used my strength wisely." Upon another occasion (recorded in my diary as August 8), referring to the recent death of a museum assistant (Dr. Maack), he said, "My time will come soon, and I am ready." Yet before his associates and pupils he main-

tained always a cheerful demeanor, and none suspected his condition to be such that his wife watched him with increasing anxiety, and during her occasional absences arranged a simple signal between his room and mine (directly below) which should notify me of his sudden illness or need of aid.

Saturday, the 26th of July, was a red-letter day for all. Minor events were the collection of a Gunellus, an Echineis, two rays, and one shark; the brains of all were exposed, compared by the class, and then preserved. The finding of eggs in the oviducts on both sides of a ray caused Agassiz great joy, while to most of us, hailing, as we did, from "fresh-water" institutions, it was a kind of revelation. But the crowning event was the arrival of Arnold Guyot, Agassiz's fellow-student, collaborator, and life-long friend. Strongly contrasted in certain respects, but both eminently handsome, as they strolled about the island with arms thrown over each other's shoulders, they made a picture at once charming and majestic and never to be effaced. They were united even in their discourses. Naturally, the advent of Guyot made glaciers a leading topic, and at a pause in the lecture of either the other would interpolate, "No, Louis," or "Yes, Arnold; don't you remember so and so?" etc. Indeed, the presence of Guyot constituted a natural climax to the scientific idyl at Penikese.

Yet the delightful spirit of the time and place did not preclude hard work. From morning to night and during the evening all were occupied. Whether guiding or following, imparting or receiving, demonstrating or observing, instructors and pupils alike were striving to increase both their own knowledge and that of others; nor does there rise in my memory a single instance of self-seeking upon the part of any connected with the school.

How else could it be with the example of the master ever before us? No longer young, exhausted not so much by work (although that had often been excessive) as by responsibilities and uncongenial administrative duties, commanding from one hundred to five hundred dollars for a single public lecture, yet often with "no time" to that end, at Penikese he lectured almost daily, sometimes twice a day, and was an attentive lis-

tener to the instruction of his associates. In the laboratory or in the field encouragement and inspiration emanated from him. In our minds he appeared encompassed by a halo of self-sacrifice that would have been only larger and more radiant could we have foreseen the impending result of his labors.

The situation has been feelingly described by one who could most keenly appreciate it:

> It was to me supremely touching to see the great naturalist at Penikese a few months before his death devoting his last strength to a crowd of eager learners, directing them to the exclusive study of the book of nature, and showing them, by word and deed, how to observe it and how to be taught by these living realities.[1]

Even had the future been revealed to Agassiz, it may well be doubted whether his efforts would have relaxed. A surprising benefaction had enabled him to materialize a long-cherished educational ideal, and he might have chosen deliberately to consecrate thereto the last summer of his life. In establishing, within three months, upon an uninhabited island not readily accessible, an institution where teachers — men and women alike — were led from the consultation of books to the personal interrogation of Nature, Agassiz not merely overcame the inertia of matter and the apparent limitations of time and space; like another Swiss, upon a different field, he gathered to his devoted breast the spears of ignorance and indifference, of covert ridicule and open opposition, and made way for the advance of knowledge along paths till then unbroken. "Peace hath her victories no less than War."

Yet had there been no such material outcome as the many summer schools since established, all connected with the Anderson School in 1873 will regard those weeks as an epoch in their lives; to their pupils and to their pupils' pupils forever will be transmitted the story of what was said and done, seen and heard while they had the honor and the happiness of being with Agassiz at Penikese.

[1] Guyot, *Memoir of Louis Agassiz*, p. 46.

EDITORIALS.

March, 1848, the Beginning of a New Era in the History of Zoology in America. — It is interesting to review the condition of the natural sciences, and especially of zoology, in the United States half a century ago. The pioneers of those days are rapidly passing away, but the records of the societies, the journals, and the isolated books give one, in outlines at least, the status of zoology, while the reminiscences of the older men give the picture vitality. Looking over these old pages and numbering the stories the fathers have told us, we can conjure up, more or less vividly, those primitive days with their inadequate library facilities, their small museums supported only by the greatest self-sacrifice of the few, and also the low esteem in which "bug-hunters" were held by the general public. Indeed, it was at a much later date that Stimpson, hunting for shells in the refuse brought in by the fishermen, was stoned as a crazy man by the men and boys of Marblehead.

From such a review one becomes impressed with the fact that the zoology of that day was not held in high esteem by the colleges, but existed apart from them. There was, it is true, something taught that was labeled zoology in a few institutions. Baird was teaching in Carlisle, Dana at New Haven, Emmons at Williams, and Adams at Middlebury, and earlier still Rafinesque held a chair in Transylvania University in Kentucky, while Nuttall for a few years gave private instruction to a few students at Harvard. As one turns over the pages in which Adams described the shells of Jamaica and of Panama he cannot but wonder at the nature of the instruction in those days. How could it have had any human interest for the student? These exceptions aside, the great proportion of the natural history work of the country was done by men without academic position, and largely by physicians in moments snatched from a busy practice. Indeed, it was regarded as the proper training for the profession of a naturalist to begin with the study of medicine, and the present writer was advised not twenty-five years ago to attend a medical school as an introduction to the study of zoology.

There were then two great zoological centres in America, — Boston and Philadelphia. In Boston the leaders were Binney, Gould, Storer, Wyman, Cabot, Harris, Jackson, Bryant, Brown, and Couthouy;

at Philadelphia the work was being done by Morton, the two Leas, Peale, Conrad, Haldemann, Leidy, and Wilson; and it is a noticeable fact that in this catalogue of names all but two — Leidy and Wyman — were systematic zoologists pure and simple. This fact is but characteristic of the times. It was the day of species describing. There was a wealth of undescribed forms, and the recently organized state surveys, as well as the government expeditions, were daily bringing in new forms to describe, new species to catalogue. When we leave these two cities we find the zoological devotees scattered here and there throughout the country: Mighels at Portland, Wheatland and Cole at Salem, Nichols at Danvers, Tufts at Lynn, Dana and Ayres at New Haven, Fitch at Salem, N.Y., Bailey at West Point, Dekay at New York, Holbrook, Bachmann, Gibbes, and Ravenel at Charleston, Hentz in Florence, Ala., and Kirtland at Cleveland. That curious zoological centre at New Harmony had already broken up and its members were scattered or dead.

The means of publication were few, and the bulk of the zoological papers appeared in the records of the societies of Boston and Philadelphia, two in either city. Besides these there were publishing societies in New York and Salem, while other places, like Hartford, published one or two numbers and then passed out of the scientific world. The only strictly scientific periodical was the *American Journal of Science and Arts*, although now and then a magazine like the *Naturalist* of Boston ran a brief course. It necessarily followed that many a scientific paper was forced into the medical and agricultural journals and buried there almost beyond hope of resurrection. There was but one other means of getting results into print and that was open to but the few. We refer to the State Surveys which came into existence but a short time before, the publications of which reached their scientific height in the survey of Massachusetts, but were published in the most sumptuous form by the state of New York.

Such in outline was the condition of zoology in America half a century ago. It was almost entirely what we now know as systematic zoology and it was all but ignored by the colleges, all of whose energies were turned in the direction of the classics, mathematics, and metaphysics. The times were ripe for a change. In the records of Harvard University is to be found the following minute:

"At a stated meeting of the President and Fellows of Harvard College in Boston, Sept. 25, 1847. Present, President Everett, Dr. Walker, Mr. Lowell, Mr. Curtis, Treasurer Eliot.

"*Voted:* That this board do now proceed to the election of a Professor of Zoology and Geology in the Lawrence Scientific School in the University at Cambridge. Whereupon, ballots being given in, it appeared that Professor Louis Agassiz, late of Neuchâtel, Switzerland, was chosen.

"*Voted:* That the President be requested to lay this election before the Board of Overseers, that they may concur in the same if they see fit."

According to the statement in Marcou's *Life of Agassiz*, we are led to infer that this appointment was accepted in February, 1848. In March Agassiz began his instruction at Harvard, and with it there began a new era in zoological science in America. Anatomy and embryology were henceforth to assume their proper position, and this country was to advance along new lines, until now in morphological science it stands second only to Germany among the nations of the earth. It seems, therefore, peculiarly fitting that the *American Naturalist*, founded as it was by four pupils of Professor Agassiz, — Alpheus Hyatt, Edward Sylvester Morse, Alpheus Spring Packard, and Frederick Ward Putnam, — should pay some attention to the fiftieth anniversary of Agassiz's appearance as a teacher in America, — an anniversary which indicates not only a change in the character of zoological science in America, but as well a change in the academic position of zoology in our educational institutions. We therefore present in the foregoing pages a sketch of the life of Agassiz and reviews of some aspects of his work, kindly written at our request for this occasion.

The Fur-Seal Problem. — We are very glad to see in two or three recent numbers of *Natural Science* editorials upon the fur-seal problem in which the necessity of prohibition of pelagic sealing is admitted, if the herds of the Pribilov and Commander Islands are not to be exterminated. In fact, this journal fully supports the contention of the government of the United States. This is no more than could be expected from a scientific journal. The whole problem of the fur seal is a question of fact, and these facts are capable of but one interpretation, unless they be garbled, as was recently done by one Englishman high in authority. In a word, the position of the British government is indefensible ; but it is hardly possible to hope for any sensible arrangements until there is a change in the personnel of those who are directing the British Empire.

REVIEWS OF RECENT LITERATURE.

History of the Smithsonian Institution.[1] — The Smithsonian Institution has been so intimately associated with the progress of natural science in the United States during the last fifty years that its history is a sort of epitome of the activities of American naturalists during that period.

It originated in a bequest of James Smithson, of England, who, dying in 1829, left his property to his nephew with the provision that, in case he died without heirs, it should go "to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." His nephew dying soon after, the property, amounting to over $500,000, was paid to the government, which guaranteed forever to the institution interest at the rate of six per cent on the original sum, together with all savings and gifts added to it, to the amount of $1,000,000. The total principal is now over $900,000.

The bequest being without precedent, a protracted discussion occurred as to the best way to use the fund. A university, an astronomical observatory, an agricultural experiment station, and a meteorological bureau were urged by different persons. At about this time a society called the National Institute was organized at Washington, rapidly gained a national reputation, and made great, but vain, efforts to get Congress to unite the Smithsonian Institution with it. The opposition of Congress led to the quick decay of this society, but it, more than anything else, determined the character of the Smithsonian Institution when, in 1846, it was finally established.

The character of an institution is often determined more by its earliest executive than by its statutes. The pride American men of science take in the "Smithsonian" is largely due to what Joseph Henry was and what he made it during its first thirty-one years. The particular interest that naturalists feel in the institution is largely due to the second secretary, the zoologist Baird, who admirably complemented the work of Henry.

[1] *The Smithsonian Institution, 1846–96. The History of its First Half-Century.* Edited by George Brown Goode. Washington, 1897. 856 pp.

In considering the special lines of work of the institution most interesting to naturalists, we may refer briefly to the National Museum, the Bureau of Ethnology, the Exchange System, the Zoological Park, and Explorations.

The museum was a cherished feature of the "National Institute." It had been given charge of the collection of the Wilkes' Expedition, 1838, and when it broke up, this collection and the others it possessed passed to the Smithsonian Institution. The exploration of the Territories and donations from foreign governments and from travelers soon swelled the collections enormously, so that now a special congressional appropriation of over $180,000 per annum is required to maintain them.

The Bureau of Ethnology, which had its germ in Major Powell's explorations of the canyons of the Colorado and of this whole river basin, 1867–69, and had passed an embryonic existence under the "Geographical and Geological Survey of the Territories," was born as a distinct bureau when the Geological Surveys were reorganized in 1879.

The System of International Exchanges was proposed by Henry, 1847, in his original plan of organization. Originally it related only to the exchange of government publications; but later the service was extended to the international exchange of publications between scientific societies or between societies and individuals. This work has grown so that it now requires a special congressional appropriation of $17,000 per annum.

The National Zoological Park, which originated over ten years ago in Secretary Langley's desire that the National Museum should possess living animals, now includes 166 acres in the suburbs of Washington. While the great expense of its maintenance precludes its rapid growth, it is believed to be already an important safeguard against the utter extinction of several species of mammals.

As for explorations, the Smithsonian Institution has coöperated in all those of the government since 1846 and has granted subsidies to some private ones. The decade preceding 1856 was very fertile in government surveys. Among these may be mentioned the survey of Wisconsin, Iowa, Minnesota, etc., by Owen, of the Lake Superior region by Jackson and Whitney, of Oregon by Evans; the survey of the boundary between the United States and Mexico, and later of the Gadsen Purchase; the Pacific Railroad surveys along the 47th parallel, the 41st parallel, the 38th and 39th parallels, the 35th parallel, the 32d parallel, in California, and in Northern California

and Oregon; explorations of the Red River, the Great Salt Lake, the Upper Missouri and Yellowstone, and the survey of the Indian Territory; naval expeditions to Chile, Japan (Perry), the China seas and Bering's Strait, La Plata and its tributaries (Page), the west coast of Greenland and Smith's Sound (Kane). Later, under Baird, the institution coöperated with the marine explorations of the Fish Commission. Among private explorations aided were those of the American Antiquarian Society of Worcester, Mass., among Ohio mounds, 1851; of Samuels in California, 1855; of Kennicott in British America and Alaska; of Dall in Alaska; of Scott in Yucatan; of Berendt in British Honduras, 1865; of Orton in northern South America, 1867; of Simson in Utah, 1859; of Stejneger at the Commander Islands, 1882; of Jouy in Corea, 1883; of Rockhill in Mongolia and Thibet, 1888–89, 1891–92. Such explorations have affected not only science, but commerce.

Finally, a few words may be said about the work done in the publication of zoological and botanical investigations alone. Among zoological works we notice Scudder's *Nomenclator Zoologicus;* numerous works on zoogeography; descriptive, monographic, and faunistic works, issued either as separate "Contributions" or in the *Proceedings of the U. S. National Museum;* and a few physiological memoirs.

To these may be added valuable reports on *The Progress of Zoology, 1879–86,* and *Instructions for Collectors.* Among botanical works are the results of Wright's explorations in Texas; several expensive monographs by Torrey and by Gray, especially Gray's *Synoptical Flora of North America,* Harvey's *Marine Algæ of the United States,* Wood's *Fresh-Water Algæ,* and Leidy's *Fauna and Flora within Living Animals.*

This brief review of some of the chapters of the history which lies before us inadequately indicates its scope and value. The volume was planned and partly carried to consummation by the late Dr. G. Brown Goode. The reading of the book impresses one strongly with the single-mindedness of those who have been chiefly concerned in the management of the Smithsonian Institution. C. B. D.

Proceedings of the Indiana Academy of Science. — The volume of the *Proceedings of the Indiana Academy of Science for 1896,* dated 1897, did not reach our hands until the last of January, 1898. The volume is a larger one than its predecessors, and, like them, is an example of printing done at state expense, — a pretty poor example of typographic art. Another fault we have to find with the

work is the absence of any real table of contents, the result being that it is very difficult to refer to the papers. Aside from this the volume is up to its usual standard. Among the more important papers within the scope of our pages are the following: one by Mr. Call upon the maps of Mammoth Cave, from which we learn that no really accurate map of the cave exists, the reason probably being that the owners are afraid that some one will tap their property and force them to divide the enormous admission price charged. Professor Burrage tells us that the water supply of Lafayette has been affected by Uroglena. Messrs. Hessler, Blatchley, Chipman, S. Coulter, Arthur, and Snyder give lists of additions to the flora of the state, and Miss Cunningham revises the species of Plantago of the United States. Miss Cunningham has studied the effects of drought upon the tissues of several cultivated plants, while M. B. Thomas repeats well-known statements regarding periodicity of root pressure. Messrs. Bitting and Davis have studied the bacteria of stables, and Miss Golden concludes that common yeasts have little or no pathogenic properties.

In the zoological field Mr. Rittger gives in outline a study of a digenic trematode found in pond snails and artificially fed to ducks, in which the adult condition was obtained. Mr. Butler adds to the list of Indiana birds and gives a detailed account of the bobolink within the state. Mr. Call gives an account of the aquatic mollusca of the state, and their relations to the river basins; 195 species are enumerated, and of these 130 are reported from the Wabash basin and 127 from the Ohio. B. M. Davis gives a poorly arranged, but nearly complete, bibliography of the pineal structures. Dr. J. R. Slonaker presents an abstract of his paper on the fovea of the eye, printed in full in the *Journal of Morphology*.

The study of the lakes, so prominent in other volumes of these proceedings, is largely ignored in the present volume, while geology and archeology are represented by but few papers. Dr. Moore gives an account, with a plate, of the Randolph County mastodon, now in the possession of Earlham College.

ANTHROPOLOGY.

The Races of Europe.— Dr. J. Deniker, in the *Bulletin of the Society of Anthropology of Paris*,[1] presents a "second preliminary

[1] *Les race de l'Europe*, tome viii, No. 4, p. 291.

communication" relating to his researches upon the races of Europe. A provisional classification is offered, subject to modification if necessary, as the investigation continues. This classification is based solely upon somatological characters at present. By taking three characters, as the cephalic index, stature, and color, and dividing each into three degrees, twenty-seven combinations are possible. Deniker's researches demonstrate the existence of six clearly marked combinations and four of less prominence. He therefore divides the people of Europe into six principal and four secondary races. For convenience of reference, I have formulated the following table from his detailed descriptions:

NAME (as given by Deniker).	COLORATION.	CEPHALIC INDEX.	STATURE.	
1. *Race Nordique*	Blond	72 to 78	1.72 M	Corresponding to the Germanic, Cymric, or Reihengräber race of certain anthropologists.
2. *Race Orientale*	Blond	82 to 83	1.63 to 1.64	Includes the Bielorouses, certain Lithuanians, etc.
3. *Ibero-insulaire*	Brunette	74 to 75	1.61 to 1.62	Spanish Peninsula, Sardinia, Sicily, etc.
4. *Occidentale* or *Cévennole*	Brunette	85 to 87	1.63 to 1.64	The Celtic, Celto-ligurian, Celto-slave, or Alpine race of various anthropologists.
5. *Race Littorale* or *Atlanto-méditerranéenne*	Brunette	79 to 80	1.66	Atlantic and Mediterranean coasts.
6. *Adriatique* or *Dinarique*	Brunette	85 to 86	1.69 to 1.71	Extending with interruptions from Belgium to Croatia.

Prof. W. Z. Ripley, in his paper upon "The Aryan Question,"[1] divides the races of Europe into three groups, according to their cephalic index and other physical characters. The Mediterranean and Teutonic types are derived from that paleolithic long-headed race which first occupied western Europe. Later a round-headed race of "decidedly Asiatic affinities" invaded the country. They are most nearly represented at the present time by the Alpine or Celtic type of central Europe.

[1] The Racial Geography of Europe. Appleton's *Pop. Sci. Mon.*, vol. lii, p. 304.

Dr. Deniker believes that he has established a basis upon which to build deductions from the facts relating to archæology, topography, linguistics, etc. It will be noticed that his preliminary conclusions differ materially from the final results of Professor Ripley's careful studies. We shall await with interest for further accounts of Dr. Deniker's work; it may assist in establishing the true value of the data upon which the Anthropo-sociologists, Ammon, Lapouge, and all "these head fellows" depend. At present this mathematical method seems to be too seductively easy.

FRANK RUSSELL.

ZOOLOGY.

The Development of Fresh-Water Bryozoa.[1] — Another grand quarto on fresh-water Bryozoa by Braem. As many observations of broad interest are included in this work, it is desirable that especial attention should be directed to them.

Spermatogenesis. The spermatogonia contain a large nucleus with one or two nucleoli and a "Nebenkern." The number of chromosomes in the first division was not exactly made out; it was between twelve and sixteen. During the second division the number is smaller (six to eight), so that the first is doubtless the reducing division. The cytoplasms of a large number of spermatids fuse into a single mass; the axial filaments of the tails arise and are of cytoplasmic origin; the neck is formed by the aggregation at one point of microsomes that were previously scattered all about the nucleus; the head arises from the nucleus in that the chromatin first accumulates at one pole, then the nuclear sap is eliminated, and the whole body becomes smaller and dense. An erythrophile substance also passes from the nucleus into the cytoplasm.

The ovarian eggs have a nucleolus which is often dumb-bell-shaped or double and contains one or more contracting vacuoles. The cytoplasm exhibits two concentric zones, of which the outer contains large, deeply staining granules of unknown origin. Maturation stages were not observed.

Fertilization takes place in the ovary. The egg then passes into an "oœcium," — a modified polypide, — to the wall of which the ovary may be said potentially to belong.

[1] Braem, F., Die geschlechtliche Entwickelung von Plumatella fungosa. Zoologica, Heft 23, 96 pp., 8 plates.

Cleavage was traced to thirty-two cells, which remain broadly united to one another at the centre of the whole mass. The extraordinary conclusion is reached that some of the deeply staining ("chromatic") bodies of the outer zone of the egg form, during its first cleavage, nuclei, which have, however, no further rôle.

Gastrulation and mesoderm-formation, long misunderstood, are cleared up. In the 32-cell stage, four cells enter the blastula cavity at the upper pole; they represent the entoderm. This degenerates, and a pseudo-blastula results. An ingression of cells at the upper pole of the now much larger embryo follows: this is the mesoderm-formation. Thus the primitive entoderm is wholly rudimentary.

The pair of *primitive polypides* also arise at the upper pole and the larva is soon thereafter born. The position of the primary polypides seems reversed in Gymnolæmata and Endoprocta as compared with Phylactolæmata, for in the former groups this polypide arises at the pole at which gastrulation occurs.

In regard to the *law of sequence of buds*, Braem insists on the wide difference between the budding of Phylactolæmata and Gymnolæmata, since new polypides arise on the oral side of the old ones in the former, and on the anal side in the latter group. He forgets, however, that in both groups the anal side of the young bud is turned towards the source of its tissue.

The work before us is destined to become a classic. The typography is of the best. Eight quarto plates, by Werner and Winter, contain drawings which, while trustworthy, are almost diagrammatically clear. C. B. D.

Lepidosiren. — From *Natural Science* we learn some facts regarding the development of the dipnoan, Lepidosiren, of Paraguay. Mr. J. Graham Kerr, of Cambridge, aided by a grant from the Balfour fund, went to Paraguay to obtain material for a history of this animal, and apparently was very successful in his search. Lepidosiren occurs in considerable numbers in the swamps, is rather sluggish, and comes to the surface at short intervals for respiration. Its food consists of the large snail, Ampullaria, and of confervoid algæ, the young being more vegetarian in their diet than are the adults. The animal makes a burrow in the ground at the bottom of the swamp, lines it with soft grass, and in it deposits her eggs. These eggs are very large, about 7 mm. in diameter, and, in the developing eggs, have a thin and horny coat, derived from a gelatinous coat which surrounds the eggs before oviposition. The segmentation is holoblastic and

unequal, and the process of gastrulation recalls that of the urodeles and cyclostomes. From the egg there hatches a tadpole which develops external gills and a very large sucker of the amphibian type. Both suckers and external gills disappear in about six weeks after hatching, but not until ten or twelve weeks does the larva feed for itself, living up to that time upon the yolk. During the breeding season the papillæ on the hind limbs of the male grow out into long blood-red filaments, apparently ornamental in nature. In the night the normally dark color of these animals changes to nearly white, the black chromatophores being retracted in darkness. In the dry season Lepidosiren behaves much like Protopterus, retreating into the mud and breathing by means of an air hole.

From this brief outline it would appear that Lepidosiren presents considerable similarity in its development to Ceratodus, as made known to us by the investigations of Semon.[1] The eggs in this form measure 6.5–7 mm. in diameter; segmentation and gastrulation are much the same, but in Ceratodus the envelope is gelatinous, while neither suckers nor external gills are developed. The similarities of both of these dipnoans to the Amphibia in their external development is very striking, but this does not of necessity imply any close relationship between the two groups. One recalls in this connection the larval forms of Lepidosteus, as described by Agassiz, and of Amia, as figured by Allis and by Dean.

Fishes of the Vicinity of New York City.— Mr. Eugene Smith has just published an excellent list of "the fishes of the fresh and brackish waters in the vicinity of New York City" in the *Proceedings of the Linnæan Society of New York.*

The list comprises 61 species, 24 being native fresh-water species, 11 introduced species, and 26 belonging to brackish waters or running up the rivers to spawn. The list is accompanied by brief but accurate descriptions and by useful notes on the local distribution. The work is neatly and correctly done, and should be followed by an equally exact list of the marine fishes of the same region. Curiously enough, our knowledge of the local fish fauna of New York Bay is still incomplete. D. S. J.

[1] *Jena. Denkschriften*, Bd. iv, 1893.

BOTANY.

Ripening of Fleshy Fruits. — Mr. C. Gerber contributes a paper of 280 pages on this subject to *Ann. d. Sci. Nat. Bot.*, 8th ser., tome iv, nos. 1–6, 2 pl. He studied the behavior of many fruits, — apples, pears, peaches, plums, grapes, oranges, lemons, melons, medlars, loquats, persimmons, bananas, etc. In the space of a short review it is possible to mention only a few of the many interesting facts set forth. Some of the changes which take place in the ripening of fruits are :

(1) The acids, malic, tartaric, citric, are partially used up in the formation of carbohydrates.

(2) The tannin disappears by complete oxidation, without forming any carbohydrates.

(3) The starch is transformed into sugar.

(4) The saccharine substances partly disappear by oxidation.

Mr. Gerber finds that the odors of certain fruits are due to the asphyxiation of the cells, alcohols and volatile acids (acetic, formic, etc.) being formed and these uniting to form agreeable ethers. The asphyxiation of the ripening fruits is due to the development of pectin, which swells, closes up the intercellular spaces, and shuts out the air. If the fruits are then kept at a sufficiently high temperature, so that the life processes of the cells go on rapidly, more oxygen is necessary than can filter through the swollen tissues and that in the sugar is drawn upon, but only after the tannin has entirely disappeared, *i.e.*, the sugar is broken down with the formation of acids and alcohols (and subsequently of ethers) and the liberation of carbon dioxide. At lower temperatures the cells of the fruits are able to get the small amount of oxygen required for their life processes from the air, and consequently no volatile acids, alcohols, or ethers are formed. This is why such fruits as persimmons and bananas are destitute of odor when ripened in cool places. The facts of respiration are as follows :

(1) Sweet fleshy fruits in certain phases of their development liberate in a given time a volume of carbon dioxide greater than the oxygen absorbed, so that the respiratory quotient $\left(\frac{CO_2}{O}\right)$ is greater than unity.

(2) This special respiratory quotient has a different origin and progress, according to the stage of ripening and the chemical principles in the fruits. Two kinds of quotients superior to unity are

distinguishable, one due to the presence of acids, the other to the lack of air and the resultant production of alcohol.

(3) The quotients of acids occur whenever fruits containing these acids (citric, tartaric, malic, etc.) are exposed to a sufficiently high temperature, — 30° C. and upwards for fruits containing citric and tartaric acid, 15° C. and upwards for fruits containing malic acid. Quotients of acids are also found in fatty plants.

(4) The quotients of fermentation are produced whenever the oxygen of the air fails to reach the cells in sufficient quantity to furnish the energy necessary for vital activity.

(5) The quotient of fermentation differs from the quotient of acids in the following ways :

(*a*) By the time it appears, — end of maturity.

(*b*) By the lower temperature at which it can take place, — even at 0° C. in case of some fruits.

(*c*) By its value, — often above 3, while that of acids is always below 2 and generally less than 1.5.

(*d*) By the corresponding respiratory intensity, — the amount of oxygen absorbed after the quotient of fermentation appears is much less than before, while the quantity of oxygen absorbed after the quotient of acids appears is much greater than before.

(*e*) By the change which takes place when sections are made, — sectioning slightly diminishes the quotient of respiration and scarcely increases the corresponding respiratory intensity, while it considerably raises the quotient of acids and at the same time greatly increases the respiratory intensity.

Since the acids and tannins disappear rapidly at high temperatures, the ripening of sweet fleshy fruits containing acids (apples, grapes, oranges) or tannins (persimmons) or a mixture of acids and tannins (sorbs, medlars, pears) may be hastened by exposure to warmth. The ripening of fruits containing much acid and not subject to fermentation due to asphyxiation (certain apples, grapes, cherries, oranges, etc.) may be retarded by exposing them to temperatures approaching 0° C., since at low temperatures the acids are not oxidized. On the contrary, fruits containing tannin, and which present at the close of ripening a quotient of fermentation (sorbs, medlars, persimmons, bananas), cannot be preserved much longer at low temperatures than at high ones, since the tannin is oxydized as well at one temperature as at another, and immediately after its disappearance the pectose is transformed into pectin, oxygen is excluded, the period of fermentation sets in, and the fruit

softens. Finally, the need of a high temperature for the combustion of tartaric and citric acid and the possibility of the oxidation of malic acid at lower temperatures explains why apples, sorbs, medlars, and other fruits which contain malic acid are able to ripen in cold climates, while grapes and oranges require warmer climates. It also explains why fruits containing malic acid ripen in cool places after picking, while grapes, and especially oranges and other citrus fruits, do so only imperfectly. However, by raising the temperature, fruits containing citric and tartaric acid will ripen in the fruit house.

E. F. S.

Ferns of Nicaragua. — An attractive-looking piece of work bearing the above title forms the second paper in the *Bulletin from the Laboratories of the State University of Iowa*, vol. iv, No. 2, pp. 116–224. The author of the paper is the well-known zoologist Mr. B. Shimek, who collected these plants on the island of Ometépe in Lake Nicaragua and in a narrow strip of country along the San Juan River. Over 120 species of ferns were collected in this small area in less than four months devoted to general botanical work. Judging from Mr. Shimek's statements, the fern flora of Nicaragua appears to be even richer in species than that of New Zealand, but the individuals are not so numerous. Only about one-fifth of the species listed by Mr. Shimek occur in Fournier's list of 121 Nicaragua ferns, and only about two-fifths in Mr. Helmsley's list of 135 species. Much of the territory is still only very imperfectly explored. The paper contains some interesting general remarks on tropical ferns, a key to the orders and families, and a list of the species collected, including helpful notes and a citation of books in which descriptions may be found. Several species are transposed into other genera, and one new species is described, — *Polypodium macbridense.* The text is supplemented by twenty well-executed half-tone plates.

E. F. S.

Pharmaceutical Archives. — With the beginning of the current year, owing to the large amount of original matter offered for the columns of the *Pharmaceutical Review*, the journal has been relieved of much of this matter by the starting under the same management of a second journal under the heading given above. The first number contains articles on the comparative structure of the leaves of *Datura stramonium*, *Atropa belladonna*, and *Hyoscyamus niger*, the popular names of Brazilian plants and their products, a chemical bibliography of morphine, and a study of the structure of the twigs

of *Fraxinus americana.* Though primarily intended for the pharmacist, these articles are of no little value to the botanist, and Dr. Kremers is to be congratulated on the promising outlook for his new journal. T.

Indiana Botany. — Several articles in the *Proceedings of the Indiana Academy of Science* for 1896, recently issued, are of interest to botanists; namely, "Notes on the Flora of Lake Cicott and Lake Maxinkuckee," by Robert Hessler; "Notes on Some Phanerogams New or Rare to the State," by W. S. Blatchley; "Periodicity of Root Pressure," by M. B. Thomas; "Notes on the Flora of the Lake Region of Northeastern Indiana," by W. W. Chipman; "Additions to the Published Lists of Indiana Cryptogams," by L. M. Underwood; "The Bacteriological Flora of the Air in Stables," by A. W. Bitting and C. E. Davis; "An Experimental Study on the Pathogenic Properties of Common Yeasts"; "Exceptional Growth of a Wild Rose," by Stanley Coulter; "A Revision of the Genus Plantago occurring within the United States," by Alida M. Cunningham, in which *P. minima* and *P. rubra* are described as new; "The Effect of Drought upon Certain Plants," by Clara A. Cunningham; "Additions to the Cryptogamic Flora of Indiana," by J. C. Arthur; "The Uredineæ of Tippecanoe County," by Lillian Snyder; and "The Occurrence of the Russian Thistle in Wabash County," by A. R. Ulrey. As might be expected, the papers are of very unequal value, and while those of local interest are useful, if somewhat fragmentary, the one monograph is scarcely likely to add materially to a knowledge of the group it deals with.

Sugar Cane. — The Bureau of Agriculture and Immigration of Louisiana has recently issued the first volume of a treatise on the history, botany, and agriculture of sugar cane and the chemistry and manufacture of its juices into sugar and other products, by Prof. W. C. Stubbs, Director of the Audubon Park Experiment Station at New Orleans. One chapter is devoted to the botanical relations of the plant, one to its anatomy and physiology, one to its modes of reproduction, and one to bacteriological notes on red cane. The remainder of the volume is historical and agricultural.

Digestion in Pitcher Plants. — It has been variously claimed that the digestion of proteides in the pitchers of Nepenthes is due to a digestive ferment secreted by them and to the action of bacteria growing in their secretion. Professor Vines, in the *Annals of Botany*

for December, 1897, gives additional corroboration of the former claim, since he shows that the secretion digests fibrin in the presence of one per cent. hydrocyanic acid, and that its enzyme retains its digestive activity when kept for several weeks in pure glycerine. His studies do not reach to the secretion of the necessary acid, which, in one species at least, is present in the liquid of unopened pitchers, and therefore is not the result of stimulation by the presence of foreign bodies.

Primitive Angiosperms. — From a morphological study of Naias and Zannichellia,[1] Professor Campbell shows that both anthers and ovules are axial structures, approaching, as he believes, more closely to the sporangia of Pteridophytes than do those of any other angiosperm, and he seems inclined to look upon these genera as standing nearer to the diverging point of Isoetaceæ and monocotyledons than do most representatives of the latter group.

New Species of Pectis. — Mr. M. L. Fernald, of the Gray Herbarium, contributes to the knowledge of Mexican plants by publishing in vol. xxiii, no. 5, of the *Proceedings of the American Academy of Arts and Sciences* a paper on some rare and undescribed plants collected at Acapulco by Dr. Edward Palmer in 1894, and a systematic study of the genus Pectis, including species of the United States as well as Mexico. Of this genus, *P. Lessingii*, *P. prostrata*, var. *cylindrica*, and var. *urceolata*, *P. sinalœnsis*, *P. depressa*, *P. capillaris*, var. *paucicapitata*, *P. filipes*, var. *subnuda*, *P. Pringlei*, *P. Rosei*, *P. elongata*, var. *Schottii*, *P. ambigua*, and *P. linifolia*, var. *marginalis* are described as new.

Botanical Notes. — Botanists will be interested in knowing that the herbarium and notes of the late M. S. Bebb, a collection invaluable for any systematic study of North American willows, have been purchased by the Field Columbian Museum of Chicago.

An article on "The North American Genus Sarracenia," illustrated by a reproduction of a photograph of *S. Chelsoni* (*S. rubra* × *purpurea*), is to be found in *Gartenwelt*, of Berlin, of Dec. 26, 1897.

Students of European botany, who have found difficulty in resigning themselves to the use of one name for the terra-cotta-flowered and blue-flowered forms of the poor man's weather-glass, which they

[1] D. H. Campbell, Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University. XI, A Morphological Study of Naias and Zannichellia. Reprinted from *Proceedings of the California Academy of Sciences*, 3d ser., Bot., vol. i. San Francisco, Cal., 1897. 61 pp., 5 pl.

have found almost side by side in various places, will appreciate a critical article on the annual species of Anagallis of Europe, which M. Clos publishes in No. 7 of the *Bulletin de la Société Botanique de France* for 1897.

A note by M. Franchet, in No. 7 of the *Bulletin de la Société Botanique de France* for 1897, shows that, though certain reduced forms of *B. lunaria* have been mistaken for it, *Botrychium simplex* really occurs in France.

Another application of anatomical characters to the delimitation of species has been made by Gillot and Carmentier, who show, in No. 7 of the *Bulletin de la Société Botanique de France* for 1897 that *Rumex palustris* is a hybrid of *R. maritimus* and *R. conglomeratus.*

In a paper on "The Spruces of the Adirondacks," read before the Albany Institute in November, 1897, Professor Peck states that, though until recently only two species of Picea were credited to the Adirondack region, there is now good evidence of the presence there of four species: *P. canadensis*, the white spruce, *P. mariana*, the black spruce, *P. rubra*, the red spruce, with a dwarf variety, *P. rubra pusilla*, and what is held to be a new species, the swamp spruce, *P. brevifolia*, with a dwarf variety, *P. brevifolia semiprostrata.*

That the active use of insecticides and fungicides, promoted by the publication of "Spray Calendars" and the like by our Agricultural Experiment Stations, is being watched with interest in England, is shown by the publication in the December number of the *Journal of the Royal Horticultural Society* of a rather extended paper by S. C. Lamb on "The Treatment of Insects and Fungi in the United States."

To cultivators of hothouse plants an article on the genus Nepenthes, by H. J. Veitch, published in the December number of the *Journal of the Royal Horticultural Society*, cannot fail to prove of interest. In it are given a historical account of the introduction of these Old World pitcher plants into cultivation, and a number of ecological and cultural observations. Several species are figured, some of them in the early stages of development.

That the botanists of far-away New Zealand are active is shown by the *Transactions and Proceedings of the New Zealand Institute* for 1896, recently received, which contains no less than twenty-one botanical articles, among them several of considerable ecological interest.

No. 230 of the *Journal of the Linnæan Society, Botany*, is given up to the completion of a paper by Sir John Lubbock on buds and

stipules, in which it is shown that the protective scales of winter buds may be either pedestals of last year's leaves, modified bases of leaves, leaf blades, modified leaves, stipules, connate pairs of stipules belonging to the same leaf, or connate pairs of stipules belonging to different leaves.

In the issue of *Science* of Dec. 17, 1897, Dr. J. W. Harshberger published an article on "The Native Dahlias of Mexico," in which, especially, the conditions under which these popular garden plants naturally occur and their natural color variation are made the subject of inquiry.

The mucilage cells of Opuntia have been made the subject of a recent study by Longo,[1] who states that they occur distributed through the fundamental parenchyma of all members of the plant, that their mucilage does not result from a transformation of the cell wall, but is a direct product of their protoplasm, and that their function is that of a water tissue. The same author has also[2] studied certain crystal and mucilage cells which are found in the branches and fruit of Platopuntias, though absent from the Cylindropuntias.

To students of the African flora the series of papers on Italian collections of Harar and Somali plants being published by the staff of the Berlin Garden in current numbers of the *Annuario* of the Botanical Institute of Rome should be of interest. A number of new species are described.

[1] *Annuario del R. Ist. Bot. di Roma*, **7**: pp. 44–57, pl. 2.
[2] *Loc. cit.*, pp. 79–83, pl. 8.

SCIENTIFIC NEWS.

THE circulars of the Marine Biological Laboratory at Woods Holl have been issued. The elementary zoological course will be under the direction of Prof. James I. Peck, assisted by Messrs. Dalgren, Greene, Lefevre, Murbach, Packard, and White. The botanical work will be directed by Prof. Bradley M. Davis, with the assistance of Messrs. Moore, Caldwell, Harper, Fairchild, Webber, Swingle, and Mrs. Esten. Physiological studies will be directed by Prof. Jacques Loeb, assisted by Messrs. Norman and Lyon. The work in elementary embryology will be in charge of Messrs. Lillie, Strong, Crampton, Treadwell, and Miss Clapp, while the zoological investigation will be conducted by Professors Ayers, Bumpus, Conklin, McMurrich, Metcalf, Morgan, and Morrill. New features are seminars in embryology and neurology, conducted by Drs. Conklin, Morrill, and Strong, and a course of instruction in methods of illustration by Dr. Arnold Graaf. The laboratory intends to incorporate in its tenth report a historical sketch of the institution. The session for 1898 extends from June 29 to August 10. The prices charged are the same as in previous years.

It has been proposed to rebuild the museum at South Kensington, London, and Parliament will be asked to grant an appropriation of £3,000,000 for the purpose.

The New York Public Library has received $10,000 from Mr. Jacob H. Schiff for the purchase of scientific works.

Mr. George Sharman has resigned his position as paleontologist of the Geological Survey of Great Britain, and Mr. George K. Cherrie that of assistant director of ornithology in the Field Columbian Museum of Chicago.

The Museum of Comparative Zoology has recently acquired a fossil ostrich egg from the neighborhood of Pekin, China. It has almost exactly the same dimensions as the *Struthiolithus chersonensis* of Brandt.

For some time *Science* has been publishing a series of articles by different persons dealing with the question of the age of the implements found in the Trenton gravels. The layman in such matters is left in doubt between the various conflicting claims, but with a general feeling that these relics cannot have the great age sometimes attributed to them.

Prof. E. Ray Lankester has been elected Fullerian Professor of Physiology in the Royal Institution of Great Britain. He is to give a course of seven lectures on the simplest living things. This appointment does not interfere with his position in the University of Oxford.

The Geological Society of London has awarded the Wollaston medal to Prof. F. Zirkel, the Murchison medal to T. F. Jamieson, and the Lyell medal to Dr. W. Waagen.

In the editorial department of this journal for February a plea was made for the exercise of common sense in questions of scientific nomenclature. In *Science* for January 21 Dr. Theodore N. Gill has a case in point. In 1852 Dana recognized a genus Arctus and took for his type the *Scyllarus arctus* of Fabricius. Now, since Arctus was the only species known to Fabricius, Dr. Gill proposes to overturn this work which has stood for nearly half a century, to refer Arctus back to the genus Scyllarus, and to refer those species which later students assigned to Scyllarus to a new genus Scyllarides. We doubt if almost "every zoologist" will admit the necessity for the change. Why not leave well enough alone? The proposed change merely introduces confusion where all was simplicity before.

Prof. Thomas Jeffrey Parker, of the University of Otago, New Zealand, died at Dunedin, Nov. 7, 1897. He was the son of the late William Kitchen Parker, and received his scientific training at the hands of his father and of Huxley. From 1872 to 1880 he was demonstrator of biology at the Royal College of Science, South Kensington. In that year (1880) he went to New Zealand, where he remained until his death. He was most widely known by his books, *Instruction in Zootomy* (1884) and *Lessons in Elementary Biology* (1891), but he had published numerous articles dealing chiefly with Vertebrata and Crustacea. Shortly before his death, in connection with Prof. W. A. Haswell, he had completed the manuscript of a text-book of zoology just published by the house of Macmillan.

The University of Chicago makes appropriations of $729,000 for the University year beginning July 1, 1898. Among the items we note the following: for the faculty of arts, literature, and science, $347,000; libraries, laboratories, and museums, $44,000; printing and publishing, $41,000. The total number of graduate students in the university is 324, of whom 122 are women.

At the meeting of the Yale Corporation held on the 13th inst. O. C. Marsh, professor of paleontology, formally presented to the University the valuable scientific collections belonging to him, now

deposited in the Peabody Museum. These collections, six in number, are in many respects the most extensive and valuable of any in this country, and have been brought together by Professor Marsh at great labor and expense during the last thirty years. The paleontological collections are well known, and were mainly secured by Professor Marsh during his explorations in the Rocky Mountains. They include most of the type specimens he has described in his various publications. The collection of vertebrate fossils is the most important and valuable of all, and includes, among many others, (1) the series of fossils illustrating the genealogy of the horse, as made out by Professor Marsh and accepted by Huxley, who used it as the basis of his New York lectures; (2) the birds with teeth, nearly two hundred individuals, described in Professor Marsh's well-known monograph, "Odontornithes"; (3) the gigantic Dinocerata, several hundred in number, Eocene mammals described in his monograph on this group; (4) the Brontotheridæ, huge Miocene mammals, some two hundred in number; (5) Pterodactyles, or flying dragons, over six hundred in number; (6) the Mosasaurs, or cretaceous sea-serpents, represented by more than fifteen hundred individuals; (7) a large number of Dinosaurian reptiles, some of gigantic size. Besides, there are various other groups of mammals, birds, and reptiles, most of them including unique specimens. Additional collections comprise extensive series of fossil footprints, invertebrate fossils, recent osteology, American archæology and ethnology, and minerals. The main conditions of the gift, which is for the benefit of all departments of the university, are that the collection shall remain in a fireproof building, and under the control of Professor Marsh during his life, after that under the charge of the trustees of the Peabody Museum, and, finally, that type specimens shall not be removed from the museum building. From a scientific point of view, the value of the collections is beyond price, each one containing many specimens that can never be duplicated and already are of historical interest. Altogether, this is the most important gift to natural science that Yale has yet received.

Franz Kempe, of Stockholm, has endowed a chair of vegetable biology in the University of Upsala with $40,000 and has nominated Dr. A. N. Lundström of Ultuna as the first occupant.

Dr. Rodolfo Amando Philippi, on account of his age (ninety years), has resigned his position as Director of the National Museum in Santiago, Chile. His son, professor of natural history in the university there, has been appointed his successor.

Prof. Hans Molisch, of Prague, is spending a year in the botanical gardens at Buitenzoog.

Dr. Karl Futterer, of Carlsruhe, has gone on a geological expedition to Central Asia.

The University of Bonn has received the valuable anthropological collections of the late Mr. Schaafhausen.

The library of the late Prof. Carl Vogt has been purchased by the Senckenberg Society of Frankfurt am Main.

Some years ago the Boston Society of Natural History attempted to establish zoological gardens and aquaria in Boston, but from the first, as a result of impracticable plans, the project was doomed to failure. Recently the idea has taken another form, and the mayor of the city, Mr. Josiah Quincy, in his inaugural address, recommended that the city itself take up the work, which it was estimated would involve an expenditure of about $200,000.

The gypsy moth still makes demands upon the Massachusetts Legislature. The state has already expended considerably over half a million dollars in the attempt to exterminate the pest, and for the coming year the committee of the State Board of Agriculture having the work in charge ask for an appropriation of $200,000 for the work in 1898. That the insect can be kept in check cannot be denied, but that extermination of it can be accomplished does not seem so certain to us as it does to the committee. It is proposed by some to limit the appropriation to $75,000.

Recent Appointments: Dr. Abelous, professor of botany in the University of Toulouse, France. — Dr. Otto Finsch, director of the collection of ornithology in the Leyden Museum. — Dr. Hollermann, privat docent in botany in the University of Berlin. — Dr. Julius Istvánffy, professor of botany in the University of Klausenburg, Hungary. — W. P. Pycraft, temporary assistant in ornithology in the British Museum. — Mr. Francis Ramaley, of Minneapolis, assistant professor of botany in the University of Colorado at Boulder. — Dr. L. Rhumbler, privat docent in zoology in the University of Göttingen.

Recent Deaths: Charles Cornevin, professor of zoology and hygiene in the veterinary school at Lyons, France. — Dr. Mietschke, a German entomologist. — George H. Piper, geologist, of Ledbury, England. — Dr. F. Sintenis, German student of Diptera. — Prof. Ernst Ludwig Taschenberg, entomologist, of Halle, Jan. 20, 1898. He was born Jan. 10, 1818.

CORRESPONDENCE.

To the Editors of the *American Naturalist:*

I have recently had occasion to do some work which involved the comparison of genera in several groups of vertebrates, and in my studies I have made some discoveries which were rather surprising to me. For instance, I find our thrushes, in many works, distributed between two or three genera, our wood thrush being in the genus Turdus, the common robin in the genus Merula. The sole differences I find recorded between these two genera are best shown in the deadly parallel:

TURDUS.	MERULA.
Bill much widened at the base.	Bill little widened at the base.
Tarsi decidedly longer than middle toe and claw.	Tarsi little longer than middle toe and claw.
Spotted beneath.	Beneath mostly unicolor with streaked throat.
Of small stature and rather slender form.	Large, stout.

Again, I find our pestiferous English sparrow in the genus Passer, while the purple finch is in the genus Carpodacus. The distinctions between these two genera are:

PASSER.	CARPODACUS.
Bill without nasal ruff.	Nasal ruff little developed.
Culmen curved.	Culmen moderately curved.
Commissure little angulated.	Commissure decidedly angulated.
Gonys convex, ascending.	Gonys straight.
Wing five times the length of carpus.	Wing not quite five times the length of carpus.
Wing pointed by first three quills.	Wing pointed by first three or four quills.
Tail shorter than wings.	Tail much shorter than wings.
Tail nearly even.	Tail forked.
Tarsus about equal to middle toe and claw.	Tarsus shorter than middle toe and claw.
Lateral toes of equal length.	Lateral toes subequal.
Claws of lateral toes not reaching to base of middle claw.	Claws of lateral toes reaching the base of middle claw.

Turning to the higher groups, I find families distinguished by characters of hardly more importance, thus:

TURDIDÆ.	SYLVIIDÆ.
First primary short, strictly spurious.	First primary short, sometimes strictly spurious.
Bill rather long, usually notched at the tip.	Bill slender, notched, and decurved at the tip.
Tarsi always booted.	Tarsi usually booted.
Tail shorter than wings.	Wings longer or not longer than tail.
Tarsus little, if any, longer than middle toe and claw.	Tarsus longer than middle toe and claw.
Basal joint of middle toe attached its whole length externally, halfway internally to adjacent toes.	Inner toe free; outer toe united to middle toe for not half its length.
Size medium.	Size small.

Now, with this preamble, my question is this: Are these genera and families equivalent to genera and families in other groups? To me it would seem that the distinctions between Merula and Turdus and between Passer and Carpodacus are not equivalent to those used to distinguish even subgenera in other groups of vertebrates or invertebrates; while the family characters quoted would be of not more than generic rank in, say, reptiles or fishes. However, this is merely the opinion of one not an ornithologist, and I would like the views of other naturalists upon the subject. Cannot you induce students interested in the systematic study of vertebrates — ornithologists, mammalogists, herpetologists, and ichthyologists — to express their views upon the matter? I am sure that a discussion of the questions involved would interest many readers of the *American Naturalist*.

ZOOLOGIST.

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